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A STUDY

IN THE

Epidemiology of Tuberculosis

With Especial Reference to

TUBERCULOSIS OF THE TROPICS AND OF THE NEGRO RACE

BY

GEORGE E. BUSHNELL, Ph. D., M. D.,

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PREFACE

To understand tuberculosis of the temperate zone and of our race it is necessary to know something of tuberculosis as it affects other races which live under different social, economic and climatic conditions. No apology is therefore needed, it is hoped, for this little book, although the views as to tuberculosis set forth in it are not supported by any original investigations of the author. The aim has been, rather, to collect and discuss facts and in so doing to make known to the English-speaking public some of the very important but little known epidemiological data which have been published in widely scattered and often more or less inaccessible periodicals and, the greater part of them, in foreign tongues. With this end in view the writer has not scrupled to make copious extracts of papers on the epidemiology of tuberculosis, mostly from the German, for the translation of which he assumes the responsibility.

The work in its first draft was an essay on tuberculosis of the tropics and of the negro race. It has outgrown its original framework, but it has been thought best to retain the references to the tropics, especially those which have a practical bearing upon prophylaxis, treatment and the like. While the principal object of the writer has been to further the acceptance of certain views of universal applicability in phthisiology, he has also borne in mind the need which exists of a greater clarity of the conception of tuberculosis as a practical problem affecting races as yet not fully tuberculized and hopes that what he has written may serve, not

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so much as a formal treatise on tuberculosis, but rather as a study which by emphasizing certain important but too much neglected distinctions may stimulate inquiry and may also prove of some practical benefit to the physicians who encounter the disease in remote regions. The tuberculosis of the civilized negro has been discussed in some detail, not simply because of its interest as an epidemiological study, but also on account of its practical importance to the citizens of the United States.

Great difficulty has been experienced in determining what the truth is as to the prevalence and severity of tuberculosis in various parts of the world. With regard to some countries it has proved impossible to form any conception as to what the actual facts are. No attempt has therefore been made to report upon all tropical countries — there is little use in repeating statements that tuberculosis "rages" here or there, if no further information is furnished. It is the way of the epidemiologist to write pessimistically on tuberculosis, as if something could be gained by creating alarm. But this is not the standpoint of the writer. If tuberculosis is really ravaging the world and if nothing can be done to restrain it as a world-plague, the proper course is to dismiss the unpleasant subject from one's mind as completely as possible. On the other hand, if there is a prospect of improvement rather than of deterioration — and the experience of the last half-century should encourage us to believe that this is the case — every one interested in the prevention of the disease should be anxious to lend a hand wherever possible.

The suggestions as to a practical program in the epidemiological study of our own communities, as well as those of other peoples, are submitted with much diffidence with a view to stimulate thought and investigation.

The role of the von Pirquet test in the epidemiology of tuberculosis is destined, it is believed, to become of increasing importance. Especial attention has therefore been paid to it in the hope that the Anglo-Saxon may be inspired by the example of the French and of the Germans to make use of it on a large scale — not only in the tropics, but also at home.

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Epidemiology of Tuberculosis

CHAPTER I

THE PRE-KOCHIAN ERA

It is difficult for us who have so long known that tuberculosis is a transmissible disease to place ourselves in the position of the practitioners of previous generations who for the most part believed it to be non-infectious. It is true that in countries like Italy where the disease was comparatively rare, it was believed to be highly infectious, but this belief originated there rather in the fear of an unfamiliar malady than in any definite pathological conception. Early medical writers differed greatly among themselves as to this point, but on the whole the verdict was against the infectiousness of the disease. Laennec[1] speaks of the contagiousness of tuberculosis as very doubtful and cites the familiar facts as to the absence of infection among those who nurse the tuberculous but goes on to say that many facts also show that a disease which is usually not contagious may become so under certain circumstances. Even Villemin's experiments which to our minds definitely prove the infective properties of tuberculous sputum and tissues were not frankly accepted in such a way as to influence medical practice. For example, Flint states as late as 1873: "The doctrine of the contagiousness of the disease (tuberculosis) has now as hitherto its advocates but the general belief of the profession is in its non-communicability."[2] As von Behring says the decisive victory of Ville-

[1] Cited by Von Behring, Beitr. z. Experimentellen Therap. Heft 11, p. 20

[2] Austin Flint, Practice of Medicine, 1873.

min's doctrine was gained only after the discovery of the tubercle bacillus.[1] The problem then was to account for a disease — consumption — which was not due to infection and which had its seat in the lungs. What more natural under the circumstances than to class it with other respiratory diseases, bronchitis, laryngitis, pneumonia. These diseases according to the prevailing view were non-infectious and were caused by exposure to the weather, and especially by sudden chilling of the surface of the body; consumption therefore was to be regarded as brought about in the same way. To explain why all who were subject to exposure did not fall a prey to the disease the assumptions of a hereditary predisposition and of an acquired cachexia, or, as Flint puts it, of a diathesis whether always innate or in certain cases acquired, became necessary. But the important point in the present connection is that the prominence which has been given to climate as a curative agent depended primarily upon the assumption that pulmonary tuberculosis as a disease of the lung is originally caused and is influenced in its progression by meteorological influences like the other diseases of the lungs the most conspicuous clinical symptoms of which are cough and expectoration. Hence the use of cough medicines and of derivatives, the warm seat by the fire, the window tightly closed to keep out draughts.

Joseph A. Gallup in Remarks on Pulmonary Consumption which are appended to his "Sketches of Epidemic Disease in the State of Vermont from its first settlement to the year 1815" expresses the opinion that conditions of hard labor and scanty fare do not produce so many consumptions as indolence and luxury. Upon the same principle, he says, much riding and milk diet or low regimen have been found

[1] Loc. cit.

useful oftentimes in the cure and prevention. By low regimen Gallup meant bread and milk alone or combined with a vegetarian diet. "In certain very low states however and also after hope of recovery is relinquished, if the patient should have a particular desire for more nourishing food as meat, oysters, etc., he may be indulged." Venesection should be employed more or less extensively according to the severity of the case. "The author has frequently treated cases of phthisis of delicate habit by bleeding with advantage beyond his most sanguine expectations." After the proper curative means have been used a sufficient length of time moderate exercise may give relief. To receive permanent benefit it should be almost constantly employed even to the point of fatigue. This heroic treatment was probably about the same as that which the author would have employed in gouty bronchitis. Evidently he conceives of consumption as an analogous disease. It appears from some of his remarks that his methods had received criticism by physicians of the newer school. As to etiology he says: "The disease appearing chiefly in certain districts in the same latitude gives a strong presumption that some deleterious elementary principle is necessary to its production. Its appearing mostly in the middle latitudes is presumptive that the extreme and sudden changes of temperature from heat to cold and the reverse have a controlling influence." We may paraphrase this somewhat obscure utterance as follows: Since whatever the ultimate cause of consumption may be the disease prevails more in certain districts than in others, in view of its non-contagiousness the observed differences as to prevalence are best explained by ascribing them to meteorological conditions. But consumption is more prevalent in the temperate zones than elsewhere. The distinctive characteristic of these zones

from a meteorological point of view being a wide range of temperature with rapid alternations, it is the sudden changes of temperature that govern the appearance of the disease. The succinctness of the author's statement of his views and the absence of argument in their support show that he believed that he was expressing the prevailing theory of his day, and felt no need of explaining in what way vicissitudes of temperature could have so serious results. Evidently his opinion is that consumption, like other respiratory diseases, is due to "taking cold."

But when at a later date it became necessary to explain how it was that consumption was so serious a disease in the mild and equable temperature of the South Sea Islands alternations of temperature could no longer be advanced as the cause. It is now the imprudence of the sick man that is to be blamed. Gallup would never have dreamed of saying that the greater prevalence of consumption in certain parts of the United States was due to the fact that the inhabitants of those districts were especially careless about wet feet or about sitting in draughts. But what would have been absurd if said of a homogeneous people in whom a certain average degree of prudence is to be assumed seemed quite in place when applied to a foreign race to which the author holds himself superior. Turner writing of the Samoa of 1868 says: "Chest affections of all kinds, cough, asthma, bronchitis, phthisis, etc., are very frequent. This is to be accounted for principally by the extreme carelessness of the natives sitting down right in a strong draught in order to cool off or exposing themselves to the injurious night dews which are so heavy in these islands."[1] Rochard writing in 1856 likewise considers chilling of the body a

[1] Notes of Practice in Samoa, Glasgow Med. Jour. Vol. 2, 4th Series, 1869-70, p. 502.

cause of consumption. "The majority of deaths at Tahite," he says, "are due to pulmonary phthisis which kills with extraordinary rapidity. Its ravages among the natives are explained by their mode of life, the insufficiency of their clothing, their habitations open to all winds, the abuse of cold baths, their recklessness when ill and above all their incredible libertinage."[1] Another medical writer sets himself the difficult task of explaining the relative prevalence of tuberculosis and of disease in general. Dutroulau[2] in his works published in 1858 and in 1868 on the climatic conditions of the various French colonies treats especially of the effect of tropical climates upon the French of the military and naval establishments and the colonial civil officials, classes which are admitted into colonial hospitals and figure in the government reports. As for pulmonary tuberculosis he says, rare at Senegambia and Mayotte, where the reign of epidemics comprehends all the pathology, it figures notably in the statistics of all the other hospitals and there is no medical report that does not emphasize the fatal influence of the climate upon the rapidity of its course. For him the more or less sudden, more or less great variations of temperature in hot countries are only the accidents of meteorology and do not constitute its pathological action which resides in the constant elevation and the slight variability of the averages (of temperature, humidity, etc.). A sense of suffocation arises from the efforts of respiration necessary to compensate by quantity for the lesser oxygenation of the air inspired, efforts that result in fatigue and in the continual excitation of the pulmonary tissue, that is to say, in organic debility and mor-

[1] Mémoirs de l'Académie de Médecine. Vol. 20, 1856, p. 75.

[2] Traité des Maladies des Européens dans les Pays Chauds. Paris, 1868, p. 104. Topographie Médicale des Climats Intertropicaux. Paris, 1858, p. 120.

bid activity. Let there be some perturbation of the new functions which have devolved upon the skin (as from changes of temperature we will suppose) and immediately the effect is felt in the internal organs; the germs of disease which they contain receive an impulsion which hastens and activates their symptomatic explosion. But, he hastens to add, the fact must not be lost sight of that the physiological modifications in the functions of the lung and skin are due to the elevation and non-variability of the meteorological elements much more than to their variations. Otherwise one would not understand why in Senegambia where the variations of humidity and of temperature are carried to an extreme pulmonary tuberculosis is little heard of while at Cayenne where the variations are imperceptible and the average always high the disease develops and progresses with remarkable rapidity. Other observers may think that atmospheric changes are the cause of disease but Dutroulau evidently prides himself on his ingenious solution of the problem: "Why is Cayenne worse for consumption than Senegambia"? and specifically calls the attention of physicians to his view which he says differs from that of others. The difficulties however are not all removed. He had given humidity as one of the causes which really underlie the pathology of tuberculosis. Now Cayenne is one of the most humid spots in the world while Senegambia on account of the proximity of Sahara is relatively dry. The unwary might think that the humidity of Cayenne accounted for its inferiority, certainly in these days of the reign of bacteriology that is what we should conclude. But the ingenious author is not to be caught so easily. He remembers that he must provide for the fact that the heights of volcanic islands are more humid and more rainy than the plains but nevertheless are more

healthful, which he says they owe to the nature of their soil. "The hygrometric state of the atmosphere is only a direct and powerful cause of insalubrity in relation to the geological nature of the soil; the vapor of water dissolves the miasms." With the aid of this obscure ally every pathological situation might, it would seem, be explained, but it is much easier to frame a theory that will account for the relative healthfulness of two countries than one that will fit everywhere. There is Cochin-China, for example, to be reckoned with, Cochin-China which he says seems an exception to all rules. For there it is not the wettest time of the year, when (the reader would suppose) "the miasms" would be dissolved with especial facility that is the most unhealthful but the second quarter when the rains are just commencing. "The first impregnation of the soil by the waters is doubtless the cause of this phenomenon, also the first appearance of the southwest monsoon."

Another Frenchman writing at about the same time as Dutroulau was reaching very different conclusions. Jourdanet[1] had to account for the fact that in the towns of Campeche and Merida in Yucatan tuberculosis is an acute affection which kills quickly while in Tabasco the disease is rare. Now Tabasco lies in a swampy region while Campeche and Merida are built upon a dry and calcareous soil. Evidently then, Jourdanet thinks, the dry and calcareous soil must be unfavorable for phthisis and he fortifies his position by the statement that it was once the custom to send the phthisical from Campeche and Merida to Valladolid, a town of the interior on a damp site and surrounded by rank vegetation, experience having shown that the course of phthisis was less acute there.

The foregoing examples illustrate the contradictions

[1] Le Mexique et l'Amérique Tropicale, 1864.

which result when general conclusions are drawn from limited observations as to the influence of climate.

Hirsch[1] is the most prominent early systematic writer in the domain of geographical pathology. The second volume of the first German edition of his Handbook was published in 1862-1864. He recognizes the unsatisfactory nature of much of the enormous mass of data that he had collected and the unscientific way in which observations as to the influence of climatic conditions upon consumption have been made, and condemns the generalizations which are so frequently made from insufficient data as fatal for the study of the etiology. If one would throw light upon this dark subject, he says, it will be necessary to remember that in the genesis of consumption as in most of the other non-specific forms of disease we have to do not with one definite pathogenic factor but usually with the combined action of several more or less directly pathogenic factors. The mistake of over-emphasizing one factor at the risk of underestimating the importance of the others is made by those who give so much weight to purely meteorological conditions. Climate can not be the essential factor, for consumption has appeared in many localities which had formerly been spared without there having been any change in climatic conditions. The mean level of the temperature has no significance for the frequency or rarity of phthisis in any locality, and temperature-changes are important only in their effect upon the humidity of the air; they have no etiological importance when the air is absolutely dry. Just as very moist air is an important causal factor in catarrh and bronchitis so also is it for consumption, those countries which have the most consumption being distinguished by a

[1] Handbuch der Historisch-geographischen pathologie. 1st German Edition, 1862-64, Vol. 2, p. 74.

high degree of humidity, those on the other hand which possess an immunity from the disease having mostly a surprising dryness of the air, or, with average moisture, a very equable temperature. Climate and weather have influence upon the occurrence or the geographical extension of tuberculosis in so far only as they are influential in producing directly or indirectly more or less continuous and severe irritation of the respiratory organs, especially the lungs, as the result of which there first appears catarrhal affection of the organ which with continuance of the noxious influence becomes a *locus minoris resistentiae* and, in the presence of a predisposition otherwise induced, a focus of the morbid process. Elsewhere he says summarily "The source of the disease is to be sought in social not in meteorological conditions." The predisposing causes Hirsch finds in denseness of the population to which, *ceteris paribus*, the frequency of tuberculosis is directly proportional, further in sedentary modes of life with the resulting loss of exercise and of fresh air. Uncivilized people when they come first into contact with Europeans imitate their mode of life and receive physical harm by so doing. Some races, as the negro race, have a racial predisposition. He denies that the geological formation or the character of the soil has any importance in the causation of tuberculosis.

Consumption then in his definition is a non-specific disease which attacks a lung already damaged by injurious atmospheric influences provided that a (very ill-defined) predisposition is present, which predisposition is in some way connected with density of population and a sedentary life. Nothing could better illustrate than this definition the difficulties under which our fathers labored in their endeavor to account for the course and dissemination of tuberculosis considered as a non-infectious disease.

It is unfortunate that the manner in which tuberculosis comported itself when first introduced among an absolutely uninfected race could not have been carefully studied by skilled observers. The islands of the Pacific, on account of their isolation, would have been peculiarly favorable places for such study. But the first dissemination of the disease took place in the days when tuberculosis was not believed to be infectious. Captain Cook rediscovered the Sandwich Islands in 1778 and no ship has visited the islands of the Pacific since his day that has not borne with it the seeds of disease to these scattered peoples, who are probably all now more or less infected with tuberculosis, however great their isolation. Naturally no ship captain thought for one moment of such a danger, and if it had ever occurred to any one of them as a possibility, neither he nor indeed, for that matter, the large majority of the physicians of the present day would have conceived the idea of danger of contagion from the healthy members of the crew who were bacillus-carriers, while no articles given in barter would have been considered potential sources of infection unless they were known to have been used by a consumptive. So that whatever other infections they may have bestowed no doubt the crews of the ships that had left the fatal gift of tuberculosis sailed away with a perfectly clear conscience so far as that disease was concerned. Of course early visitors to the tropics soon noted that consumption did not prevail among the natives. Hence the natural inference that since the disease was due to climatic influences, the climate of the place which showed so singular an immunity would be beneficial for those who were already affected with it. As a result of this view European consumptives were encouraged to visit the tropics in order to reap the advantages of the climatic conditions. The Catholic sisters in the French

Congo, for example, imported from Europe many of their order who had tuberculosis in the hope of curing them. But the results of this experiment, according to Garnier, were disastrous.[1] When in later years the disease had become disseminated through the native populations, on account of the prevailing view of its non-communicability the facts were necessarily interpreted not as an evidence of the infectiousness of tuberculosis but as showing that the former observation as to its absence must have been erroneous. It may appear singular at first sight to one who reads Dutroulau's works that he considers only the European colonist in his studies of the relation of tropical climates to the incidence of tuberculosis. But from his standpoint this was the scientific way of approaching the subject, for whatever particular meteorological conditions might be given the chief blame for inducing consumption Europeans and natives were equally exposed to them, with the advantage on the side of the natives of better acclimatization, while statistics were only available for the Europeans. Doubtless many early cases of primary tuberculosis failed of recognition as such, for acute tuberculosis is not easy of diagnosis. Finally however it became impossible to disguise the fact that tuberculosis of the lungs was making serious inroads upon the native population, and that the type of the disease was very fatal and relatively acute. The conclusion drawn from this was of course that Europeans were exposed equally with the native to the dangers of infection with a particularly deadly type of this disease, and the warning was given by Rochard that European consumptives should not be sent to the tropics however mild and apparently inviting the climate. As he put it, "the countries of the

[1] La tuberculose au Congo Français. Ann. d'Hyg. et de Méd. Colon. Vol. 6, p. 306.

torrid zone are divided into two classes: in the one the countries, such as Senegambia, India and Madagascar, are so unhealthful that one could not think of sending patients to them; the other class, countries which invite confidence by the mildness of their climate, are the places where tuberculosis advances most rapidly."[1]

[1] Loc. cit.

CHAPTER II

THE MODERN ERA

The momentous discovery of Koch proved that the tubercle bacillus is the cause of tuberculosis and that therefore the disease is infectious. Climatic conditions will cease henceforth to play the chief role in the etiology of tuberculosis and pulmonary tuberculosis will no longer be regarded as a disease of the lungs simply. It was only natural that the infectiousness of tuberculosis should come into the foreground, but the doctrine was carried too far.

The physicians of the former generations were good observers. In fact they were better observers than we are because they could not depend upon the bacteriological or the roentgenological laboratory for help in diagnosis. The view of the practitioner had been that consumption was not a communicable disease, and this view was based collectively upon an enormous experience. But when it became known that tuberculosis was due to an infection the medical authorities instead of pausing to inquire what there might be of truth in so universal an opinion simply threw overboard the experience of past generations and proclaimed that all persons, irrespective of age, were susceptible to tuberculous infection from contact direct or indirect with the consumptive, an assumption that governs to-day the program of practical tuberculosis prophylaxis, to say nothing of the opinion of the medical profession.

Of course universal susceptibility did not mean universal infection, for only a minority of the population develops clinical tuberculosis. To explain the escape of the majority it was necessary to take recourse to the old doctrine of predisposition. Of all who are exposed to the infectious agent

only those will fall sick whose resistance is low, for various reasons. But it is possible (this is the distinguishing feature of the doctrine) for every individual to become infected from without provided that his resistance is sufficiently reduced. The predisposing factors were admittedly obscure in many cases, but in general, aside from the possibility of racial and hereditary predisposition, amounted practically to conditions that tend to impair the health. Hence was derived the proposition: Good health prevents the infection of tuberculosis from taking hold.

If we seek analogies in justification of this position we shall find that the escape of the healthy when exposed to infection from the virus of dangerous disease is due either to the smallness of the infecting dose or to the fact that the subject has already had the disease and has thereby acquired an immunity. But in the case of tuberculosis there appears to be no relation between the size of the infection and the development of clinical disease. Those who are most constantly exposed, the physicians and nurses of tuberculosis hospitals, the laryngologists, the mothers and wives of the consumptives do not show a higher incidence of tuberculosis than the remainder of the population. On the other hand the disease often attacks persons whose life has been most carefully shielded and who have not been known to have had any opportunity for infection — cases in which at least there has been no possibility of large and repeated infections. Under the complicated conditions of modern life it is usually possible to find evidence of contact more or less remote with cases of tuberculosis which satisfy some epidemiological writers as identifying the modes of transmission of infection.

To get at the real facts we should turn to classes

of cases in which the mode of life and the opportunities for infection have been under close observation. Nuns immured in convent cells are especially prone to become tuberculous. The same is true of prisoners, and, it appears, those in solitary confinement are more subject to tuberculosis than other prisoners. Fraenkel[1] quotes Baers, an experienced prison-physician, who says: "The great frequency of phthisis among prisoners can not be explained alone by direct infection by the bacilli in the air from the sputum of the tuberculous." Fraenkel concludes that many prisoners, not by any means only the pronounced consumptives, bring with them the germ of their disease into the prison. In such cases then the predisposing causes act not to produce infection but to make latent infection manifest disease.

Hirsch expressed the opinion that the frequency of tuberculosis is directly proportional to the density of the population. But the interesting fact developed in the last quarter of the 19th century that the mortality rate from tuberculosis was diminishing in the greater part of the civilized countries of Europe and America, and that too for the most part in the very countries in which the population was becoming more dense. Nor could it be said that there had been any very general improvement in these countries as to the sedentary mode of life and loss of exercise and of fresh air which Hirsch apparently regards as the harmful results of the density of population. Tuberculosis workers would have been glad to ascribe this unexpected amelioration to the newly instituted prophylaxis against tuberculosis. But the facts did not bear out this view. In the first place, the improvement began before the discovery of the tubercle bacillus; in the second, while the mortality

[1] A. Fraenkel, Pathologie und Therapie der Lungenkrankheiten, p. 761.

rate had diminished, the morbidity rate had not. As many cases of tuberculosis occurred as before proportionally to the population, not as many died. Infection occurred as before, there was therefore no change in the tubercle bacillus; the improvement must be due then either to diminution in the size of infections or to increased resistance on the part of the infected individual. It appeared further that the improvement in the tuberculosis mortality was associated with a like improvement in the general mortality. In other words, the general health of the community was improving and with it the situation as to tuberculosis. The improvement in the general health was no doubt rightly ascribed to various measures of sanitation and to ameliorations of the conditions of life, some of which might be considered to have lessened the opportunities for massive tuberculous infections, but which in general were not directed specifically against the tubercle bacillus. We see then that at least in some cases changes in hygiene both for good and for ill exert their effect not to prevent or facilitate infection, but to influence the manner in which the already tuberculous individual reacts to the disease. By the morbidity of tuberculosis is meant the number of cases of manifest tuberculous disease. It has been learned of late years that the number of individuals who can be shown by radiography, tuberculin tests and autopsy findings to have some focus of tuberculosis is enormously in excess of those who are usually classed as tuberculous, in fact that tuberculous infection is well-nigh universal in our civilization. This fact gives a new significance to the latency of the tubercle bacillus and leads us to inquire whether it is correct to assume that when infection has occurred the tuberculosis of the adult declares itself immediately or after a brief incubation or whether it is not more

probable that the period of latency may be indefinitely prolonged, so that everything that makes for good health not only helps the already tuberculous patient in prolonging his life or even in arresting his disease, but is operative as well in the protection against manifest tuberculosis of a vast body of individuals who are infected but whose infection remains latent.

Ranke remarked in 1910: "General hygienic measures, above all in the construction of dwellings and in canalisation, and the raising of the average income of the working man, have reduced the mortality from phthisis of the Germanic countries to an extraordinary degree. It is surprising that during the same period there has been either no

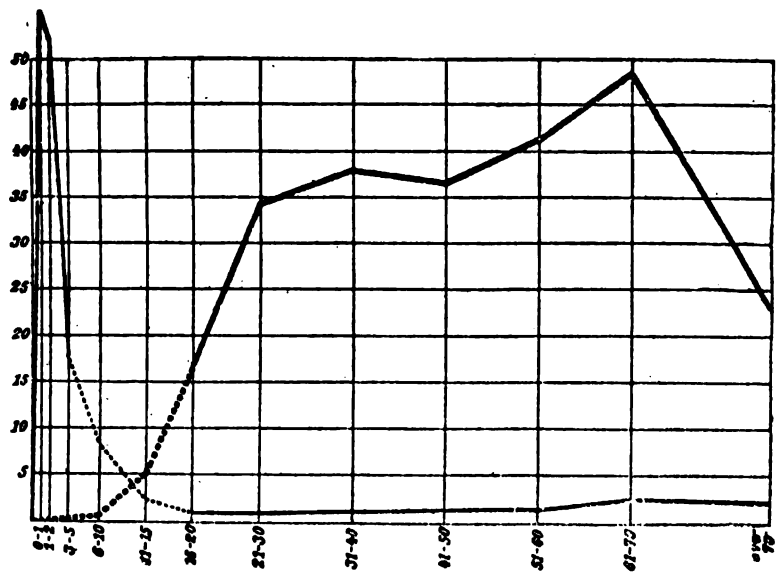

CHART No. 1

CHART No. 1.— The mortality from phthisis and from generalized tuberculosis per 100,000 living at the various ages in Bavaria for the year 1905.

Phthisis ▬▬▬

Generalized tuberculosis ———

were 100.8 and 191.5 for the same periods. In Cologne the death-rate per million for pulmonary tuberculosis was 1385 in the period 1910-1913 inclusive, and 2190 for the period 1914-1918. For tuberculosis of other organs it was 363 and 505 and for miliary tuberculosis 43.1 and 43.5 respectively for the same periods. Chart No. 3 gives the curve of the death rates for various ages. It is taken from the Statistisches Jahrbuch der Stadt Köln 1919.

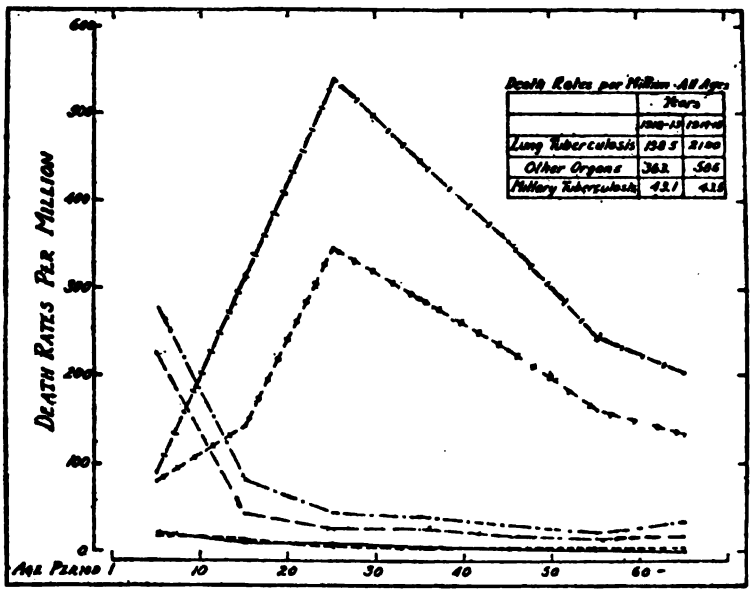

CHART NO. 3

CHART No. 3.— The mortality from pulmonary tuberculosis, tuberculosis of other organs and miliary tuberculosis per million living in Cologne, Germany, before and during the war.

Pulmonary tuberculosis, 1910-1913 incl. + + +, 1914-1918 incl. —|—|—
Tuberculosis, other organs, 1910-1913 incl. — — —, 1914-1918 incl. — · — ·
Miliary tuberculosis, 1910-1913, incl. ———, 1914-1918 incl. · · · · · ·

'This chart shows very clearly that the difference between the two periods is very marked as to pulmonary tuberculosis, distinct as to tuberculosis of other organs and

practically non-existent as respects miliary tuberculosis. Now miliary tuberculosis is the form that characterizes above all other forms of the disease the primary infection. If individuals of all ages in Germany were susceptible to primary tuberculous infection and if predisposition to primary infection were increased by depressing influence such as semi-starvation or improper diet, the increase from war conditions would be most marked in this type of the disease, but on the contrary it is precisely the most chronic type of tuberculosis which shows the greatest increase in mortality..

It is commonly taught that the acute miliary tuberculosis of the adult is secondary to an old tuberculous lesion and that it depends typically upon the irruption into the bloodstream of the contents of a softened lymph-gland which is adherent to the sheath of a bloodvessel. This pathological accident transforms the situation with startling rapidity. The subject dies of acutest tuberculosis who, though his disease was not progressing altogether favorably, might yet without such an accident have escaped clinically manifest tuberculosis altogether or might have figured among the cases of phthisis at a more advanced age.

If we turn to Chart No. 1, we will note that the curve of generalized tuberculosis after the age of three years is represented by a dotted line until the age of sixteen years is reached; that is, there are no deaths (or not a sufficient number of deaths to be plotted) from generalized tuberculosis between the ages of three and sixteen years. Similarly, the curve for the phthisis mortality is shown as a dotted line up to the age of sixteen — there is no typical phthisis until that age is reached. Of course, while the period from three to sixteen years is the period of life in which the tuberculosis mortality is lowest, there are never-

theless deaths from tuberculosis — a tuberculosis preponderatingly more chronic than the acute generalized form of earlier years, but one that is not yet confined to the lungs as is genuine phthisis, comprising what is denoted in Chart No. 3 "tuberculosis of other organs," but including many cases in which the lungs are involved. We know from the von Pirquet reaction that children of the fourth and immediately succeeding years do not yet show high percentages of sensitiveness to tuberculin. It is commonly assumed that negative cases at this age are not yet infected. It is a significant fact, however, that such children, if they die at all from tuberculosis, usually die of forms which are characteristic of an immunization — one that is imperfect because but recently acquired, yet sufficiently marked to lend a character of chronicity to the disease. The comparative absence of the generalized type can not be explained on grounds of greater maturity alone, for, as we shall see, adults may die of acutest primary tuberculosis if not protected by a previous infection. The facts lead us to suspect that children may often receive a tuberculous infection at an earlier age than that which seems to be fixed by the skin test, there seeming to be some grounds for the belief that the von Pirquet reaction is sometimes negative even in young children when tuberculous infection is undoubtedly present. Secondary generalized tuberculosis begins to show itself in Chart No. 1 in the mortality ratios in the same year of life that marks the beginning of deaths from phthisis. The mortality from generalized tuberculosis extends as a nearly straight line throughout the years of life. It does not follow the curve of the phthisis mortality for the different ages nor, as Chart No. 3 shows, is it affected by the causes that lead to an increase in the mortality from phthisis. As a "pathological accident" it is related to the

tuberculous infection of the population. In other words, a certain percentage of all living at the various ages of adult life (for after the age of sixteen all Bavarians may be assumed to have become infected with tuberculosis) are doomed to die of miliary tuberculosis because they have a softened gland adherent to a bloodvessel, or for some other more obscure reason.

Chart No. 3, which does not take into account the tuberculosis of infancy, shows miliary tuberculosis to begin about the age of five years and to continue throughout the years of life at about the same level. The distinction between primary and secondary miliary tuberculosis is not apparent here, and evidently no distinction is made between the pulmonary tuberculosis of childhood and the phthisis of the adult. But it is not necessary to attempt to reconcile the two charts nor wise to draw too strict conclusions from slight differences in curves that are designed to show in a general way the sweep of the disease over a large population. The charts, however, show clearly enough that the forms of tuberculosis that are less localized than phthisis but more chronic than acute miliary tuberculosis are much more prevalent in childhood than in later years, declining very rapidly at the period of adolescence, when tuberculization is becoming well-nigh universal and that the curves representing these forms are less affected than is phthisis by either improvement (Chart No. 2) or deterioration (Chart No. 3) in the conditions of existence.[1]

[1] The difference as to the age-periods at which the peak of the tuberculosis mortality is reached which will be noted in Charts Nos. 1 and 2, as compared with Chart No. 3, is due, of course, to the fact that in these charts the ratio is that of the number of deaths from pulmonary tuberculosis at each age to the number of persons living at that age, showing the highest mortality at about the age of sixty-five, while in Chart No. 3 deaths from pulmonary tuberculosis at the various ages are compared with the number living at all ages, the greatest absolute number of deaths taking place between the ages of twenty and thirty.

We may say then that the mortality from tuberculosis is divided into three classes as respects age and type of disease: first, the acute generalized primary tuberculosis of infancy; second, the more chronic but still not well localized tuberculosis of childhood (a miscellaneous classification including disease of bones, joints and glands as well as tuberculosis of more than one viscus); third, the well localized pulmonary tuberculosis or phthisis of the adult with the "pathological accident" of secondary miliary tuberculosis to account for a small percentage of deaths. The variations in the mortality of the tuberculosis of civilized communities which are effected by changes good or bad in the hygienic conditions are variations almost entirely of chronic pulmonary tuberculosis. Less well localized but still relatively chronic forms of tuberculosis are somewhat affected, acute primary forms and miliary tuberculosis in general are practically uninfluenced by such changes. In other words, to speak broadly, primary tuberculosis behaves like an infectious disease, chronic tuberculosis does not.

With reference to the question of the duration of tuberculous infection before the development of manifest tuberculous disease a comparison of tuberculosis with typhoid fever may be instructive. In the latter disease large infections take hold very generally upon those not protected by previous attacks of the disease without regard to the health of the subjects. But of a number of susceptible persons who are equally exposed to lighter infections not all will fall sick, some may appear to escape entirely. Here it would be correct to say that good health enables some to resist the infection with entire success. Often, especially in military practice, there may appear to be but little or no typhoid fever in a group of individuals until they are ex-

posed to conditions of especial fatigue or hardship, when such large numbers fall sick at the same time that it would seem probable that the outbreak of the disease is due to the simultaneous exposure to depressing influences of men already harboring the typhoid bacillus rather than to an immediately preceding infection. A change in the predisposition has thus caused an outbreak of a disease which though previously entirely latent for a longer or shorter time is nevertheless an acute disease. We may say then that the question whether a comparatively slight infection with the typhoid bacillus shall result in manifest disease or not is determined by the resistance of the subjects.

This is the way in which tuberculous infection is also commonly conceived of. Tubercle bacilli, incorporated in some way by persons previously uninfected, in a brief time if predisposition exists are supposed to produce a tuberculous infection, though this as a matter of fact generally manifests itself as a chronic pulmonary tuberculosis. But if there is no predisposition to tuberculosis, the individuals concerned remain perfectly healthy, escaping entirely the exposure in question. That is, in this view there is either rather quickly manifest tuberculosis as the result of the exposure to infection or no tuberculosis at all. In other words, as in acute infectious disorders, the infection is expected to declare itself with little delay and if it does not do so, the transaction is, as it were, closed.

But the tubercle bacillus is admittedly a micro-organism which is long-lived and difficult to kill and which often causes extremely chronic types of disease. We will suppose then that the tubercle bacillus is like the typhoid bacillus in that when infecting in large numbers it causes an acute general disease but that when its infections are small the result may be a latency (or obscure activity) which

resembles that of the typhoid bacillus, conditions of health in either case determining whether or not the latency shall be transformed into manifest active disease.

But in consideration of the fact that the tubercle bacillus is more sluggish and resistant than the typhoid bacillus we may also suppose that the latency that is not conspicuous nor easily determined in the case of the typhoid bacillus characterizes the tubercle bacillus much more frequently and that if after infection no disease declares itself the presumption is not that the tubercle bacillus has been destroyed as are less resistent bacteria but that it continues to live for an indefinite period. Moreover it is a fact that the tubercle bacillus when it has entered the organism does not lead a precarious existence as a saprophyte in the respiratory passages or in the alimentary canal but by virtue of the mysterious properties of its pathogenicity is enabled to penetrate the tissues and maintain itself there. Unless the tubercle bacillus differs from all other infectious organisms we must go on therefore to assume that there are interrelations between the bacillus and the human organism, that each must adapt itself to the other but that in such mutual adaptations the intensively alive and enormously complicated organism of man will go farther in modifying its activities than its enemy, a microscopic bit of poisoned wax. Under such supposed conditions where the contest is of indefinite duration it is evident that external conditions which make for health, while they do not and could not be expected to exert any marked influence upon the actual reception into the tissues of an enemy so capable of penetration, will have much influence in preventing latency from transforming itself into activity. With this supposition then what has been called predisposition to infection becomes the sum of influences unfavorable to resist-

ance to already acquired infection. The value of good sanitation now becomes enormously heightened because it is no longer simply called upon, as in the theory of predisposition to make an effort once for all to destroy an acutely infecting bacillus, but is to exert its influence through many years, indeed through life, to aid in the long struggle against an entrenched enemy. We are no longer compelled to admit the absurd view that a supposedly known recent infection results in a chronic benign pulmonary tuberculosis. And we are no longer involved in the difficulties which arise when we attempt to explain the enormous difference which exists between the chronic pulmonary tuberculosis of the adult and the acute generalized tuberculosis of the infant. With the old view the difference was one of age — the adult organism was more resistant by virtue of its maturity. An anatomical difference has been sought in the greater permeability of the delicate mucous membrane of the infant, but this has been disputed as an anatomical fact, and if true is far from an adequate explanation. With the new view the difference is one between an acute infection with massive dosage of an unprotected organism on the one hand and on the other the progress of an infection localized and made chronic by an existing partial immunity of more or less long standing, the existence of an immunity through infection being necessarily inferred to account for the marked benignity of the chronic as compared with the acute tuberculous process.

We have seen that writers on the epidemiology of tuberculosis have erred in the past by drawing general conclusions from local observations. It may be inquired whether in confining ourselves to the study of tuberculosis as it manifests itself in the civilized communities of Europe and America we are not similarly in danger of obtaining a one-

sided view of the disease. For recent observations in more than one field are making it increasingly apparent that a very high degree of tuberculization exists in the communities of our civilization. The fact that all of these communities react in about the same way to the infection of tuberculosis corroborates this view. But we can not understand our types of tuberculosis until we know all of the other types of the disease. We can not comprehend how a general tuberculization influences the dissemination and progress of tuberculous disease until we know how communities and individuals fare who have not had that previous acquaintance with the tubercle bacillus. Ranke[1] feels this necessity. In discussing the different reaction to tuberculous infection of the infant and of the civilized adult he expresses doubt as to the influence of age and says that it is unfortunately impossible to determine the truth by appeal to experience for the reason that the percentage of adults who react to tuberculin tests in civilized communities is so high that we can not hope to ascertain whether the relative resistance of the adult is due to his age or to his previous contact with the tubercle bacillus. This is true so far as the civilized adult is concerned but not for the members of some of the savage races of the tropics and other remote parts of the globe where the last and vanishing opportunity is to be found for determination of the important question: what is the reaction of the uninfected adult to tuberculous infection? We will therefore proceed to inquire how the tuberculosis situation in the tropics appears in the light of the new facts as to the infectiousness of tuberculosis.

Climatic conditions are now no longer regarded as the essential cause of tuberculous disease. But the tropical climate has not lost the evil reputation which it had ac-

[1] Loc. cit.

quired in the days when it was believed to be chiefly responsible. It is still given a role in the etiology, but now as one of the factors not usually of lung disease, as in former times, but of that practically unknown condition of the human organism which permits tuberculous infection to lay hold upon it, which is called predisposition. Yet as before there is no agreement as to the especial meteorological conditions which are prejudicial. The moist heat and stagnant air of the tropical seaboard constitute the combination of climatic influences which is mostly incriminated. But more weight is now usually given to bad hygiene, immorality, alcohol, and complicating diseases in increasing the predisposition to tuberculosis.

Now all goes well with expositions of this kind so long as tuberculosis can be described as a devastating disease and the conditions as to climate, hygiene, etc., can be described as bad. The causes assigned for the prevalence of tuberculosis might not, it is true, be the exact causes but it could not be proved that they were not; the assumptions seemed to be justified by the observed facts. But in some places the hygiene was not really relatively bad or the predisposing causes did not seem to lead to the results demanded by prevailing theory.

Le Moine, writing of the French posts in Oceania, says that tuberculosis is prevalent in these parts where life out of doors is a necessity, where hunger and want are unknown, and where all can be cleanly. But, he says, the nightly gatherings and an animal carelessness with the various excretions favor the dissemination of tuberculosis. The progress of the disease which is depopulating these islands is to be imputed to three causes, climate, syphilis and alcoholism. The climate of the hot countries is very debilitating for all human races.[1]

[1] Ann. d'Hyg. et de Méd. Colon. Vol. 6, 1903, p. 593.

Blin, writing of Dahomey, does not allude to the climate of tropical Africa but corroborates Le Moine's views as to alcoholism and syphilis. He says: "Variola, which was decimating the population, has been checked by the acceptance of vaccination. But tuberculosis, less feared because less tangible, spares no one, striking down all ages everywhere, selecting first young infants, later the adolescents. Refractory to the most elementary rules of hygiene insufficiently clothed, badly nourished, crowded into confined huts which shelter them neither from the wind nor the rain, breathing an air vitiated by crowding, committing excesses of all kinds, profoundly alcoholic, the greater part of the Dahomeyans are candidates of the first order for tuberculosis."[1]

These will suffice as examples of the effort of tropical writers to explain the incidence of tuberculosis in terms of predisposition. Increased opportunity for infection is afforded no doubt by over-crowding and by frequent gatherings, but by these authors it will be noted the stress is laid upon the personal hygiene, alcoholism and other diseases, especially syphilis, in accounting for the ravages of tuberculosis in the two races that have been most severely afflicted of late years. Now if the natives were once strong and well while living under the same hygienic conditions, however defective their hygiene may seem to us, it is not permissible to ascribe to it nor to the climate the role of creating a special predisposition to tuberculosis. On this point Mayer does not agree with Blin. He says of the African native that he is naturally cleanly, lives in a well-aired hut (one may remark here apropos of the remarks of Blin that the air can hardly be seriously vitiated by over-crowding if the hut does not shelter from the wind!) and

[1] Ann. d'Hyg. et de Méd. Colon. Vol. 6, 1903, p. 460.

on account of his scanty clothing is hardened against atmospheric changes.[1] We know that the Dahomeyans were once a race of redoubtable warriors. As for the south seas, much has been written of the ferocious cannibals who once made forays upon one another, and whatever their faults could not be accused of lack of vigor. And we shall see further on that the Samoan of the present day does not give evidence of being debilitated by his climate. As for the role of syphilis and alcohol there are other countries in which these conditions seem to have a less unfavorable effect, as for example French India, where Gouzien, as we shall see, instead of giving reasons for the high mortality from tuberculosis, is unable to explain why the death-rate from that disease is so low in view of the bad hygiene, poor food, *alcoholic excesses* and the *prevalence of syphilis* and various infectious diseases.

To explain the high mortality from tuberculosis of the African and the Polynesian some would still claim, as did Hirsch, a racial predisposition. Certain facts seem to bear out this theory; thus in British Guiana it is stated that in the negroes the course of tuberculosis is rapid and of the type of caseous pneumonia, while in the East Indian coolies it is slower, more catarrhal and bronchitic.[2] In Sumatra Chinese laborers on plantations have a chronic pulmonary tuberculosis while the Javanese under the same hygienic conditions suffer from a severe and acute tuberculosis. But there are other facts that show that race does not account for the observed differences. The Javanese country dweller is helpless before tuberculous infection, it is true, but the city dwellers of the same race are beginning to show a well

[1] Fortbldgskurse d. Allgemeines Krankenhauses, Hamburg-Eppendorf. Vol. 12, 1911, p. 23.

[2] Endemic Diseases in British Guiana and on Certain Racial Susceptibilities. Robert Grieve, British Med. Jour. Vol. 1, 1890, p. 468.

marked resistance. It is reported from German Samoa that natives imported from other islands are ravaged by tuberculosis, sixty per cent. of the deaths among them in 1909 being from that cause, but that the native population of Samoa, while they have a high morbidity rate from tuberculosis, have a very low rate of mortality.[1] But the Maoris of New Zealand, who have narrowly escaped extermination from various causes of which tuberculosis is one, belong to the same race as the Samoans. The West Indian colored regiment of the British Army has a higher rate for tuberculosis than the white troops in the West Indies but when this regiment is stationed in Sierra Leone its rate of incidence of tuberculosis is much higher than that of the native Sierre Leone regiment under the same conditions.[2] Evidently something besides racial peculiarities (in this case probably uncinariasis acquired in Jamaica where a large percentage of the population harbor the hook-worm) accounts for the fact that the regiment always has more tuberculosis than other troops with which it may be serving.

We may say that comparing with one another the utterances of the writers on tropical tuberculosis it appears that neither geographical position, climate, sanitation nor race account for the observed differences in the incidence and clinical course of tuberculosis in the tropics, and that predisposition is as unsatisfactory an explanation for susceptibility to tuberculous infection as it has proved in the temperate zones. Indeed it is more unsatisfactory. In many tropical communities the tuberculosis situation is practically the same as in the northern civilization but what shall be thought of predisposition when the incidence of tubercu-

[1] Heim, Zeitschrift für Tuberkulose. Vol. 20, 1913, p. 313.
[2] Tuberculosis among Civilized Africans. F. Smith, Jour. of Trop. Med Vol. 8, 1905, p. 19.

losis is seen to be directly as the exposure to it and healthy and vigorous men are stricken down with an acutely fatal form of the disease? Much of the confusion of apparently contradictory facts is to be explained by the existence of different types of tuberculosis.

CHAPTER III

TUBERCULIZED RACES

So far as the types of tuberculosis are concerned tropical countries may in a general way be divided into two classes. In the first tuberculosis is a prevalent disease, as it is with us, the morbidity is high, the mortality from tuberculosis is as a rule higher than the average of more civilized countries, as would be expected in populations for the most part poor and ignorant. The death-rate from tuberculosis bears a certain relation with the general death-rate, both diminishing when sanitation is improved. Chronic pulmonary tuberculosis is the common form of the disease. It is regarded as more or less curable, at all events may pursue an extremely chronic course. Tuberculosis of bones, joints and glands is more or less frequently met with. The population is generally increasing or at least there is no fear of depopulation.

In the second class tuberculosis is a comparatively rare disease, the morbidity rates are low, the mortality of those that fall sick is frightfully high. Pulmonary tuberculosis in its chronic types is rare or unknown. Tuberculosis prevails as an acute and rapidly fatal general infectious disease. It may spread like an epidemic. The population diminishes and depopulation may be feared.

Examples of the first class are the tropical portions of the continent of Asia, the Philippines, Samoa and Hawaii. Tropical Africa and the greater number of the islands of the Pacific belong to the second.

The difference between the two classes that at once attracts attention is that the countries of the first class have

long been more or less civilized or have been long in contact with civilized or semicivilized races and have therefore been exposed to infection with tuberculosis, while those of the second class contain peoples who by reason of their inaccessibility in the interior of vast continents or on remote islands of the Pacific have had little or no contact with civilization until very recent times. There are some countries which might be assigned to either group, namely those in which the seacoast and especially the seacoast cities have long been infected with tuberculosis while the interior of the country is practically free of it. An example appears to be Java. There are also many other countries as India and the Philippines where the population is composed of many different peoples in which the amount of contact with civilization and therefore probably to some extent the degree of tuberculization differ widely. The above classification is therefore only true in a general way, but it serves to call attention to a very significant distinction.

In view of the importance of a clear understanding of this matter it may be well to consider more in detail the facts regarding the character of tuberculosis as manifested on the one hand in races long in touch with civilization and on the other hand in the races nearly "virgin" so far as tuberculosis is concerned.

First, as to the old countries. In China the conditions under which the inhabitants of towns live would seem to the sanitarian preeminently calculated to result in a heavy mortality from tuberculosis. The population is densely aggregated. The houses are small and low, built closely together, badly ventilated and badly heated. The streets are narrow and crooked and, as if to ensure against free air and sunshine, it is frequently the practice to stretch an awning over them. The water-supply is badly polluted,

the disposal of faecal matter is so incredibly bad that the stenches are sometimes insupportable to the uninitiated. The majority of the people are underfed according to our ideas and what food they have is almost entirely vegetable. Yet they seem somehow to have established a *modus vivendi* so far as thoracic disease is concerned, for, according to Dudgeon of Pekin, diseases of the chest on the whole are remarkably rare in China.[1] Pleurisy, pneumonia and acute bronchitis are hardly known and phthisis is far from being as common as in this country. He reports Dr. Wang as saying that phthisis is tolerably prevalent in Canton but is by no means so common as in Europe and America.[2] It is difficult to say why this should be the case, since the causes which produce consumption, such as bad air, insufficient food and exercise, bad hygiene, etc., must be much more operative here than in the more civilized countries of Europe and America. The Chinese of Canton, according to Dr. Wang, are not liable to acute affections of the chest. He saw only one case of acute bronchitis in three years. Idiopathic pleurisy and pneumonia he had never seen, but chronic bronchitis is common. In Shanghai, according to Dudgeon, chest affections are not generally severe. At Hankow, it is reported by one physician that consumption is comparatively infrequent, which may be due, he says, to the great frequency of chronic bronchitis. Another physician says of Hankow that more than one-half of the people of the town are debarred from exercise and rarely, if ever, inhale fresh air, the subsoil is saturated with water, hemoptysis

[1] Glasgow Med. Jour. Vol. 9, 1877, p. 322.

[2] "Diseases of the viscera of an acute inflammatory nature are not so fatal or rapid among the Chinese as Europeans, nor do consumptions carry off so large a proportion of the inhabitants as in the United States." The Middle Kingdom, p. 189 (S. Wells Williams).

is of frequent occurrence. The same authority expresses his surprise at the small amount of tuberculosis among the country people who live on insufficient vegetable food. It will at once occur to the reader that the chronic bronchitis which is reported to be so frequent may be in part at least a chronic pulmonary tuberculosis. This possibility is however considered and dismissed by the reporters. Whatever the facts may be with regard to this, there would seem to be at least no doubt that the tuberculosis that is present in China is preponderatingly chronic and benign. On the other hand, according to McDill,[1] it is recently reported from Soochow, Ping Yin and Wenchow that tuberculosis is the most common of all diseases and the curse of the country; there is no form but what is met with. Patients respond well to modern treatment. These last reports are made by surgeons who would naturally see the surgical forms of tuberculosis with especial frequency. Their remarks indicate a thoroughly tuberculized population, in which the course of the disease might be expected to be benign, to " respond well to treatment," in the large majority of cases.

Hong Kong, Shanghai and perhaps Hankow are the only Chinese cities in which statistics of any accuracy are kept. Dold[2] reports as to the tuberculosis mortality of the International Settlements of Shanghai from figures furnished by the Health Office. The average mortality from all causes from 1902 to 1914 inclusive, was foreigners 17.4, Chinese 18.2 per 1000. The percentage of deaths from tuberculosis in the total mortality was: foreigners 12.53, Chinese 16.72. The average ratio of deaths from tuberculosis per 1000 of population was: foreigners 2.2, Chinese 2.7. The conclu-

[1] Tropical Surgery and Diseases of the Far East. 1918.
[2] Deutsche Med. Wochenschr, 1915, p. 1038.

sions which Dold draws from these figures are that while bad hygienic conditions in the native population account for the excess of mortality, the Chinese must be considered to be at least as susceptible to tuberculosis as the peoples of Europe and America. Among the foreigners are of course comprised many Europeans of the mercantile class, mostly males of the early and middle periods of adult life, living under comparatively comfortable conditions, who are here compared with half a million natives of all ages and both sexes most of whom are very poor and all of whom live under bad hygienic conditions from our point of view. But in the foreign population are no doubt included many Eurasians who live more unhygienically than the Chinese and are very subject to phthisis.[1] It may be granted that the statistics for the Chinese are not as accurate as those of the foreigners. But no allowance is made for the repatriation of the European tuberculous. It may be reasonably assumed that a considerable percentage of the foreigners will return to their native lands when afflicted with tuberculosis, so that the mortality rate does not furnish a true picture of the tuberculosis situation of this class. On the other hand, the Chinese of Shanghai who come from the country are sure to return to their native villages when they learn that they have consumption.[1] It is difficult to determine what the real facts are, but we may perhaps be justified in saying that the Chinese have at least as much resistance to tuberculosis as Europeans would have if compelled to live under the same conditions of hygiene.

According to Ruge[2] tuberculosis is widespread in all of South China but in Shantung is rarer than in Europe. In Chung King, Almy[3] states, tuberculosis of the lungs has a

[1] Dr. Andrew H. Woods, formerly of Canton. Personal communication.
[2] Arch. f. Schiffs-u. Tropenhyg. Vol. 16, 1912, p. 6.
[3] Klin. Jahrbuch Vol. 20, p. 403.

preponderatingly chronic course. Missionaries report that not rarely the young Chinese have attacks of hemoptysis, from which they recover completely. (The apparent innocuousness of hemoptysis among the Chinese is reported from Hankow also.) Cases are known in which European physicians have predicted speedy death in which the patients lived for years, and some even appeared to get well This in a country of cold wet winds and constant fog, the sun shining so rarely that it is popularly believed that the dogs bark at it when it does appear! Gland and bone tuberculosis are common forms. Large joints are frequently tuberculous.

In Cochin-China, Henaff reports that tuberculosis has always existed and seems to be disseminated even in the remotest parts.[1] The evolution of tuberculosis is slow and torpid, some patients reaching an advanced age. One rarely sees acute tuberculosis. There are no statistics which are reliable, but Henaff says that tuberculosis must be common in a population so wretchedly poor and so careless of hygiene. Mothers have the habit of chewing the food before feeding it to their young children and if tuberculous must often communicate the disease in that way.

Gouzien[2] states with reference to French India that it is impossible to obtain statistics because records of death are kept only by the police, but goes on to say that the low mortality from tuberculosis is surprising in view of the wretched huts in which the greater part of the inhabitants live, their poor food, uncleanness, alcoholic excesses and the prevalence of syphilis and various other infectious diseases.

In Tonkin, according to Gaide,[3] the Annamites believe that tuberculosis has always existed and that pulmonary

[1] Ann. d'Hyg. et de Méd. Colon. Vol. 6, 1903, p. 50.
[2] Idem. Vol. 7, 1904, p. 543.
[3] Idem. Vol. 8, 1905, p. 112.

tuberculosis does not develop until the thirtieth year of life. Tuberculosis of bones, joints and glands is frequent.

According to Wilkinson, statistics seem to show that tuberculosis is increasing in India.[1] It is doubtful however whether the increase is real or apparent, in the latter case being due to more accurate diagnosis and registration. Deaths in native villages are registered by uneducated watchmen, hence the statistics are unreliable. In the great cities however deaths have been reported by physicians for some years. In Madras the ratio per 1000 has fallen from 1.6 in 1905 to 0.4 in 1910. The early ratios of Bombay were high. The death-rate, 3.64 per 1000 in 1906, declined to 2.12 in 1911. In Calcutta the rate was 1.2 in 1901, 2.6 in 1907 and 2.3 in 1909, 1910 and 1911. Judging by the ratio of tuberculosis to other diseases treated in hospitals and dispensaries, it would appear that tuberculosis is on the increase. Bombay has been the worst infected city for many years and its Presidency the most infected province. The increase of industrialism has led to emigration from the country into towns, which has resulted in great overcrowding of city tenements. Seventy-six per cent. of the Bombay population live in one-room tenements with narrow passages but two feet wide between six-story buildings. Similar conditions prevail to some extent in other large towns. Muthu[2] states that he was pleased to find many cases of healed tuberculosis in places like Nepal where, though the sanitation is primitive, life is not strenuous, which confirms his experience in England that want and anxiety more than insanitation renders the human organism susceptible to this disease. The admission-rate for pulmonary tuberculosis for the Bengal army (European) according to Macpherson[2] in 1870-1879 was 8.3 per 1000, in

[1] Proc. Royal Soc. of Med. Vol. 7, Pt. 2, 1913-1914, p. 195.
[2] The Practitioner. Vol. 94, 1915, p. 872.

1879-1884 was 7 for all tuberculosis, in 1886-1890 for European troops in India was 3.5 for all tuberculosis; in 1907-1911 it was 1.60, in 1912 1.20 per 1000. The figures for both European and native troops show a rise according to Wilkinson, then a decline which is due to the providing of better barrack-accommodations. But Johnston[1] states that while the tuberculosis in the British army as shown by the admission-rate has decreased greatly since 1885, in the Indian army the rate has increased from an originally low level, the difference being due to better diagnosis of late years and to the presence of more Gurkhas who are very susceptible to tuberculosis. The barracks have been much improved of late years but those of the British army more than those of the Indian army. Pulmonary tuberculosis is practically the only form of tuberculosis in the Indian army.

In Smyrna, Barret[2] says, phthisis is rare and of slow course, but scrofula is very common in the poorer classes.

In the old French colony of Martinique, Lidin[3] states, pulmonary tuberculosis is the most common chronic disease except diarrhoea, but seems to follow the same evolution as at Paris. It generally pursues a slow and torpid course. Bone and joint tuberculosis is very rare. He quotes St. Vel, who thinks that the influence of hot climates is to tuberculize only the lungs, and states that an old physician is of the opinion that in spite of the great humidity tuberculosis is less prevalent in Martinique than in France. But in 1840, according to Hirsch,[4] Levacher reported that pulmonary tuberculosis developed in the Antilles is promptly fatal, passing through its stages more rapidly than in Europe.

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[1] Brit. Jour. of Tub. Vol. 2, 1908, p. 20.
[2] Arch. de Méd. Naval. Vol. 30, 1878, p. 81.
[3] Ann. d'Hyg. et Méd. Colon. Vol. 7, 1904, p. 84.
[4] Loc. cit.

In the French colony of Reunion, the island was originally populated by a mixed class of Malays and Africans who brought tuberculosis with them. According to Calmette,[1] tuberculous infection is as common there as in the large French industrial cities, occurring mostly as pulmonary tuberculosis. Bovine tuberculosis is said to be present — an unusual occurrence in the tropics — about thirty per cent of the milk used being infected.

In the Philippines tuberculosis is very prevalent. It is the opinion of American army surgeons who have considered the reasons for the high incidence of tuberculosis that the health of the Filipinos is impaired especially by infection with malaria and uncinariasis.[2] Improvement in the death-rate from tuberculosis as well as in the general death-rate has been effected by measures of general sanitation and also by treatment for intestinal parasites.[3] At Bilibid prison there was an uninterrupted increase in the death-rate among the prisoners from 1902 to 1905, the mortality becoming more than 200 per 1000 per annum. In 1904 more than 50 per cent. of the deaths were due to tuberculosis. Sanitary improvements reduced the mortality to about 75 per 1000. The sufferers from tuberculosis were in part isolated. Examination of the stools showed that 84 per cent. of the prisoners were infected with intestinal parasites, 60 per cent. having hookworm. Under treatment appropriate for this condition the death-rate fell to less than 20 per 1000. Deaths from tuberculosis at Bilibid were in 1904, 161; in 1905, 179; in 1906, 51; in 1907, 35. In 1914 the report is that the deaths at Bilibid from pulmonary tuberculosis numbered 55, in 1915 all deaths from

[1] Ann. de l'Institut Pasteur, Vol. 26, 1912, p. 497.

[2] W. P. Chamberlain, Am. Jour. Trop. Dis. and prev. Med. Vol. 1, 1913–1914, p. 12.

[3] Victor G. Heiser, Med. Rec. Dec. 12, 1908, p. 1006.

tuberculosis were 53 or 9.65 per 1000. In 1916 the Director of Health gives the number of deaths from tuberculosis as 33, which he states to be at the rate of 3.87 per 1000. This very gratifying result is a striking example of the benefit which may be derived from improvement of the general health in diminishing the mortality from tuberculosis in a special class of individuals coming from a community which is thoroughly infected. Manila has long been in contact with the outside world and this fact is shown by the type of pulmonary tuberculosis which prevails. According to Musgrave[1] its course is exceedingly chronic, "more so perhaps than that encountered in temperate climates."

Table No. 1 has been compiled from the annual reports of the Director of Health.

In this table no allowance is made for increase of population between the censuses. Hence in the later years (for example 1911-12 and 1916) of a period during which a constant population is assumed the ratios per 1000 living are somewhat higher than they should be. The general mortality rate and the death rates for tuberculosis are high compared with the corresponding rates of the temperate zone. According to Brewer[2] in 1908 there were 10,646 deaths from all causes at Manila. Of these 1240 or 11.07 per cent. were due to tuberculosis, a rate of 5.54 per 1000 living. The mortality rate of the United States registration area in 1910 was 15 per 1000 living, that of England and Wales 13.5, that of Germany 16.2. The death-rate from pulmonary tuberculosis in Manila in 1908 was 4.86 per 1000, that of five American cities of approximately the

[1] Phil. Jour. of Sci. B. Vol. 5, 1910, p. 313.
[2] Ibid., p. 331.

TABLE No. 1

DEATHS FROM ALL CAUSES AND DEATHS FROM PULMONARY TUBERCULOSIS WITH RATIOS PER 1000 OF POPULATION IN MANILA, P. I., FROM 1909 TO 1916.

	Population Manila	Deaths residents	Ratio deaths residents per 1000 living	Deaths transients	Total deaths	Deaths phthisis residents	Deaths phthisis transients	Total deaths phthisis	Per cent. deaths phthisis residents to deaths residents	Per cent. total deaths phthisis to all deaths	Ratio deaths phthisis residents per 1000 living
1909—10	234409	8189	34.93	538	8727	1101	144	1245	13.44	14.25	4.69
1910—11	234409	7788	33.22	491	8279	1052	130	1182	13.50	14.28	4.06
1911—12	234409	8633	36.82	652	9285	1206	153	1359	13.96	14.63	5.15
1912—13	246778	6587	26.69	875	7462	1071	185	1256	16.27	16.83	4.35
6 mos. ending Dec. 31, 1913	247756	3118	24.98	560	3678	504	81	585	19.37	15.90	2.44
1914	266943	6587	24.67	1224	7811	1003	136	1139	15.23	14.58	3.76
1915	266943	6820	25.54	1314	8134	1107	135	1242	16.23	15.27	4.15
1916	266943	7165	26.84	1324	8489	1174	149	1323	16.83	15.58	4.39

same population was: Indianapolis 1.85, Louisville 1.84, Providence 1.53, St. Paul .88.

There appears to be an improvement in the general mortality rates of the later years of this table and a slight improvement in the death-rate from tuberculosis. On the other hand the percentage of deaths from pulmonary tuberculosis in the general mortality (which of course is not affected by the failure to allow for increase of population) shows a distinct increase. A diminution in the general mortality is effected mainly by the suppression of acute infectious diseases, the result of which is that some who would have been carried off by one of these diseases live on to die of tuberculosis at a later time. As the saying is: "Not every one survives long enough to die of his tuberculosis." The table is typical of a well-tuberculized community with a fairly constant death-rate from tuberculosis, in which the hygiene is bad. Evidently much remains to be done in the way of education and sanitation.

In Brazil according to Ferreira[1] tuberculosis was more rife in the early history of the country than it is at present. In 1847 it caused one-third of the deaths at Rio de Janeiro. The ratio of deaths from tuberculosis per 10,000 population in 1860 was 122.1, in 1908 it was 41.5. Tuberculosis, he says, was particularly grave at first on account of the absence of immunity which at length develops. But improvement in sanitation has much to do with the diminished mortality from tuberculosis. For example in Recife the capital of Pernambuco, an old town where hygiene is defective, the rate is 73 per 10,000 while two other towns, Manaus and Belem, in spite of their very hot climate, being newly built and with straight and clean streets, have a mortality of 21.3 and 22 per 10,000 respectively, and this inde-

[1] Tuberculosis. Vol. 14, 1915, p. 15.

pendently of measures directed specifically against bacillary infection.

The island of New Caledonia in the Pacific was selected as a penal settlement by the French on account of its supposed salubrity and its excellent climate, Cayenne in South America, which was used for the same purpose, having proved extremely unhealthful. The first convoys were diverted from Cayenne to New Caledonia on account of an epidemic of yellow fever at the former place. There were 5187 deaths among the convicts at Cayenne in the period from 1868 to 1886 inclusive in a mean annual strength of approximately 3800. Of these deaths 472.9 per 1000 deaths were due to malaria, 81.3 per 1000 to diarrhoea and dysentery, 62.42 per 1000 to tuberculosis, 27.5 per 1000 to typhoid fever.

There is no malaria in New Caledonia. This having been the chief cause of death at Cayenne, the statistics of general mortality at New Caledonia give a ratio per 1000 often less than one-half that of Cayenne. But aside from malaria the results of the change were disappointing. At New Caledonia the deaths from diarrhoea and dysentery were 277.6 per 1000 deaths, from tuberculosis 110 per 1000, from typhoid fever 107.8 per 1000, from anemia 56.5 per 1000. Especial disappointment was felt as respects the tuberculosis mortality. While for the whole period the ratios were as has been stated 62.42 per 1000 in Guiana and 110 in New Caledonia, in the latter part of the period the ratios of New Caledonia showed an even greater increase. Thus, for example, the annual ratios of deaths from tuberculosis per 1000 deaths for the five years from 1881 to 1885 inclusive were 226, 202, 154, 122 and 93 in New Caledonia; 27, 74, 38, 46.9 and 27 in Cayenne. With the idea in part of diminishing the death-rate from tuberculosis the French

Government, instead of sending its convicts to the pestilential swamps of French Guiana, transports them to an island where the mild climate invites life in the open air and where the European is able to engage in manual labor without injury, and the result is a great increase in tuberculosis mortality! This fact, says the reporter Kermorgant.[1] has never received an explanation. Here is an interesting problem in tropical sanitation which will repay study. The explanation can not be altogether bad hygienic conditions for Kermorgant expressly states that the prisoners at New Caledonia were not overworked, spent the day in the open air and passed the night in well aired barracks in a healthful and not too warm climate. But from the standpoint of modern sanitation it is evident from the large number of deaths which are due to diarrhoea, dysentery and typhoid fever in both colonies that the water-supply was infected in both, but was considerably worse at New Caledonia. Now in a thoroughly tuberculized population in the absence of epidemic disease the mortality from tuberculosis rises and falls with the general mortality and especially with the mortality from typhoid fever and other water-borne diseases. We have therefore a higher mortality from tuberculosis at New Caledonia than at Cayenne because the water supply was more seriously infected. Furthermore the occurrence of anemia as a prominent cause of death suggests the probability of the presence of uncinariasis as a debilitating factor which might seriously favor the incidence of tuberculosis (uncinariasis has been reported from New Caledonia. Sprue which might also be considered as a cause of the anemia is, however, said not to prevail there).[2] That the convicts from France had come into previous con-

[1] Ann. d'Hyg. et Méd. Colon. Vol. 6, 1903, p. 153.
[2] Colonel Ashford. Personal communication.

tact with tuberculosis may be assumed. Whether this is true to the same degree of all the elements that go to make up the cosmopolitan population of the penal colony is of course not so certain. The Arabs had a death-rate higher than the average at Cayenne, 83 per 1000, which increased to 114.5 at New Caledonia, a smaller increase than obtained in other groups, showing that the development of the tuberculosis was less influenced by changes in the hygienic conditions. It is therefore quite possible that there were among them some individuals who had not had the full measure of protection against tuberculosis which civilization seems to confer. But that the convicts on the whole were thoroughly tuberculized is shown by comparison of their mortality with that of the prison guards. These guards were French soldiers, largely non-commissioned officers, picked men of long service, who had undoubtedly long been in contact with the diseases of civilization. In Guiana among this class the ratio of mortality from tuberculosis was 145.4 per 1000 deaths but in New Caledonia it was 228, a considerably higher mortality even than that of Arab convicts. Presumably the hygiene of the guards was at least as good as that of their charges. We must ascribe the high mortality in both classes, guards and convicts, to the same causes, in all probability causes of an infectious nature which prepare the soil for tuberculosis. Calmette[1] says of the native population of New Caledonia that tuberculous infection extends with terrifying intensity. The question that at once arises in this connection is whether or not the tuberculosis was of recent introduction among the natives, or whether, as among the whites, the special fatality of the disease is due to less obvious causes than primary infection of the race. Naturally the native would have practi-

[1] Loc. cit.

cally the same water-supply as the convicts and would be exposed to infection from the prevailing diseases perhaps even to a greater extent than the former. It is improbable in view of the long period during which the natives have been in contact with the whites that we have here a tuberculosis of a virgin race, however severe the ravages of the disease, and we are confirmed in this view by Mesnard,[1] who states that de Rochas wrote as early as 1862 that pulmonary tuberculosis was the scourge of the native population of New Caledonia. Tuberculosis is therefore no new disease. Furthermore Mesnard says that the symptoms which most attracts the attention of the natives is the emaciation of the consumptive. It seems, Mesnard goes on to say, that among the Kanakas tuberculosis has a tendency to evolve rapidly and to terminate in an atonic and torpid fashion as pulmonary phthisis. Other manifestations of tuberculosis are rarely seen. And Boyer remarks: the Kanaka is scrofulous from infancy; tuberculosis does not lay hold of him until he approaches his twentieth year.[2] Hence we conclude that not only in the penal settlements, but also among the natives, the type of tuberculosis is that of an old, well-tuberculized community. A remedy for its great prevalence is therefore to be sought in improvements in sanitation and the cure of occult infections rather than in measures addressed to the protection of as yet uninfected adults.

In Guam Odell[3] states that pulmonary tuberculosis is very common and fatal, but furnishes no statistics. Knee-joint tuberculosis is frequent in children, as is also intestinal tuberculosis. The mesenteric glands are involved in many cases and tuberculosis of the cervical glands is common in

[1] Ann. d'Hyg. et Méd. Colon. Vol. 6, 1903, p. 597.
[2] Arch. de Méd. Navale. Vol. 30, 1878, p. 228.
[3] Tropical Surgery and Diseases of the Far East. McDill.

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young adults and in children. The incidence of amebic dysentery, which is a common disease, has been much reduced since the introduction of a water-supply system and the closing of the surface wells. There is no typhoid fever nor malaria on the island. Intestinal parasites are found in almost one hundred per cent. of the natives.

On an island which has long been a Spanish colony a fairly complete tuberculization of the natives is to be expected, and this is shown to be the case by the type of tuberculosis in the young, that is, the involvement of glands and joints, and also by the fact that the fatal tuberculosis is pulmonary tuberculosis. It is to be expected that one of the benefits of the improved water-supply will prove to be a reduction in the tuberculosis mortality.

According to Cottle[1] pulmonary tuberculosis is present in American Samoa, about twelve cases having been detected in some 3000 cases of disease seen in one year. Two cases of healed joint tuberculosis are known. Pott's disease is present in about 20 old cases in the population. Tuberculous glands of the neck are quite common. Six deaths of a total of 300 deaths in children were due to meningitis. Three of these are believed to have been tuberculous. There is no typhoid fever nor malaria. Bacillary dysentery is common but never fatal unless mistreated. It is ascribed to the eating of decayed food or to overeating at feasts. An epidemic of measles in 1910 attacked practically every one under the age of nineteen years and was fatal in about eight per cent. of the cases. Dysentery during convalescence is stated to have been the cause of death. Intestinal parasites are very common: uncinaria, trichuris, oxyuris, vermicularis. It is probable that every native child carries the ascaris and every adult the hookworm, most of them

[1] Trop. Surgery and Diseases of the Far East.

also the trichuris. Examination of 70 men picked for their good hygienic surroundings, all of them members of the native guard who live in barracks, showed that all had hookworm, nearly all the whipworm and a few the ascaris. Only about ten per cent. of the native population, according to Cottle, show marked effects from this cause, probably, he says, because of an abundance of food and a small amount of hard work which nearly make up for losses occasioned by the parasites. All the children have yaws, as a rule, at the age of three to five years. The mother is willing to expose her child to infection because she believes it inevitable and thinks it better for the child to have the disease in early life. Trichophytosis and certain forms of conjunctivitis are very common.

Missionaries have been in Samoa since 1830[1] and no doubt the islands were frequently visited by traders before that date. After such a prolonged contact with civilization tuberculization of the native population is to be expected and we learn in fact that the type of tuberculosis present is the type with which we are familiar in long civilized communities — tuberculosis of the lungs, of the bones and of the cervical glands — with in addition some tuberculous meningitis, showing that in Samoa as elsewhere some of the children are exposed to massive tuberculous infections. But what excites surprise is the small amount of and presumably the small mortality from pulmonary tuberculosis. In a population of about 7000, 3000 cases of disease must represent practically the total amount of sickness. It is not therefore probable that many cases of pulmonary tuberculosis escape detection, and we must explain their small number either by the absence of opportunity for infection or by the good health and good hygiene of the population.

[1] Leber and Prowazek, Arch. f. Schiffs-u. Tropenhyg. Vol. 15, 1911, p. 409.

The fact that tuberculosis of the cervical glands is stated to be quite common, the length of contact with civilization of the community and the absence of remark as to the occurrence of acutely fatal tuberculosis in adults makes the first hypothesis improbable and it will be of interest to hear Surgeon Cottle farther as to the health conditions in Samoa. American Samoa, he says, is situated 14° south of the equator. The temperature is very equable, there being a difference of only two or three degrees between day and night and only eight or ten degrees between summer and winter. The rainfall is often more than 275 inches in the year, yet the humidity is seldom high enough to affect the health. The Samoan Islands are so isolated (three days steaming from their nearest neighbors) that they are remarkably free from the common contagious and infectious diseases. The native eats the cocoanut, banana, breadfruit and taro, a vegetable diet which gives him health and strength well above the average. Fish, pork and salt meats are the occasional luxuries added in times of feasting. The Samoan is vigorous, robust and well-developed. He can row 40 to 60 miles a day without fatigue and can travel miles with a heavy burden on his back. He can show a surprising energy and muscular endurance in his native dance and can accomplish a great deal of work in the fields. Isolation from contact with other races, government protection from commercial exploitation, an abundance of good food, carefully prepared and well cooked, a good water supply, an outdoor life, well built houses, an equable, warm climate, cleanly personal habits and a very normal type of sexual life are conditions all of which combine to make the Samoan a healthy animal. Were it not for the presence of a few parasitic and infectious diseases which affect large numbers of the population — one indi-

vidual often harboring two or more infections — sickness would be almost unknown among them. For the native the climate seems to be practically perfect.[1] Such, somewhat abridged, is the account of an eye-witness.

The conditions in Samoa as to tuberculosis are of course by no means ideal. There should be no meningitis of infants nor scrofulous glands in the necks of the adolescents. The dosage of tuberculous virus is evidently larger than is desirable for vaccination and the personal hygiene and housing-conditions are no doubt not above criticism. Yet the results reached are, it would appear, so much better than those of our own civilization that there is no comparison between them. And this in a people in which every adult harbors the hookworm and every child has the yaws!

It was to such an Arcadia as Samoa that the French government thought to convey its charges when it established the penal colony at New Caledonia. But how great the difference in results! We do not know the local conditions sufficiently to speak with any degree of positiveness as to the reasons for the marked prevalence of tuberculosis among the immured convicts. But there are some salient contrasts between the life of the natives at the two places. The French writers paint a dark picture of the moral conditions at New Caledonia. At Samoa there is no prostitution and alcoholism and drug habits are practically unknown, the importation of drugs or patent medicines without express authority and the sale of alcohol to the native being forbidden by law. While it is not believed that the Samoan is a stern moralist according to our ideas, he without doubt leads a more healthful life — possibly in part because he can not do otherwise — than the native of New

[1] Robert Louis Stevenson, "Letters." Vol. 2, p. 333, says: "Take it for all in all, I suppose this island climate to be by far the healthiest in the world."

Caledonia, whom the discharged convict, an outcast from French society, seeks to share his debaucheries and alcoholic excesses. A drunken and debauched population may be decimated by tuberculosis and uncinariasis singly or combined though, as it would seem, another people living under practically identical climatic conditions but with better hygiene may find the two scourges not incompatible with vigorous health, so far as the great majority of the population is concerned. It is greatly to be desired that a survey should be made with the aid of the von Pirquet reaction in order to determine what the degree of tuberculization of the Samoan population really is.

Tuberculosis is said to be frequent in the towns of Porto Rico. The statistics of the total incidence of tuberculosis should however be received with caution because it has sometimes been the practice to include cases of sprue under the caption " intestinal phthisis ". The form of tuberculosis which prevails is chiefly chronic pulmonary tuberculosis. Tuberculosis of bones and joints is excessively rare and glandular tuberculosis infrequently demands surgical intervention. In the country districts tuberculosis is not a common disease. A report to this effect was made by the Anemia Commission in 1904[1] and this view is reaffirmed in the report of the Institute of Tropical Medicine and Hygiene of 1914.[2] In 1913 an expedition into the interior was organized for the purpose of studying all diseases, medical and surgical, which might present themselves in the region selected, which was in the vicinity of the town of Utuado. The force consisted of three members of the Institute with the collaboration of Major (now Colonel)

[1] Report of the Porto Rico Anemia Commission, 1904.
[2] Report of the Utuado Expedition. (Reports and Collected Studies from Institute of Tropical Medicine and Hygiene of Porto Rico. Vol. 1, 1913-1917, p. 35.)

Bailey K. Ashford, Medical Corps, U. S. Army, President of the Board for the study of Tropical Diseases of Porto Rico, and one volunteer assistant, in all five physicians. Four other physicians belonging to the Anaemia Service Insular Service Sanitation, were associated with the Board of the Institute. It was intended to devote a certain amount of time to visiting the sections from which patients came but inasmuch as the personnel of the Institute was known to the country people from a previous expedition to that region nine years before, an ever-increasing number of patients thronged the clinic that had been established two miles from Utuado and made the realization of the intention practically impossible. In all 10,140 patients were examined in 60 working days, of which about 2500 were admitted to the general clinic, but only 1923 were made subjects of record, the remainder being clearly ordinary cases of uncinariasis. Generally all cases of chronic cough elicited a microscopic examination of the sputum. Pulmonary tuberculosis was found as the principal cause of disease in 56 cases and was suspected to be present in 11 additional cases. Cervical adenitis was the principal cause of disease in 9 cases, axillary in 3, inguinal in 1. There were 3 cases of tuberculous hipjoint disease and three of ganglion. The majority of the tuberculous cases came from the town of Utuado. Eight of the cases registered died in Utuado during the ten weeks devoted to the examination. The county in which Utuado is situated has 43,000 inhabitants, the town itself about 6000. Of the 10,140 cases about 76 per cent. were found infected with uncinariasis. On account of the high professional standing of these investigators their results, though imperfect so far as relates to tuberculosis, have been given in some detail. Some allowance should possibly be made for the fact that the work of

the Institute would be particularly connected with uncinariasis by the people, so that it might be anticipated that the sufferers from hookworm would present themselves especially. And they would not be likely to bring with them cases of advanced tuberculosis on sometimes long and even dangerous trips over mountain trails, nor when the daily attendance averaged some 600 persons, could it be expected that slight or incipient cases of pulmonary tuberculosis would all be detected. Making allowance for such sources of error, it would seem that the incidence of tuberculosis among the countryfolk of Porto Rico is small. Ashford had four per cent. of tuberculosis among his own patients in city and country, numbering about 4000 cases, and sixty per cent. of chronic bronchitis. The sputum of all his lung cases was examined for the tubercle bacillus. The Porto-Rican regiment appears to have a small incidence of tuberculosis. Its numbers are too small, however, to give ratios of any value for statistical purposes.

The question whether the apparent relative infrequency of manifest tuberculosis in the rural districts is due to a successful immunization of the population or to the absence of opportunities for infection is a very important one. For the latter supposition speak the often acute type of the disease when present and the prevalence of a very severe uncinariasis which, according to the prevailing ideas, would tend to break down the resistance of the already infected individual and favor the development of manifest tuberculosis. The coffee plantations of Porto Rico appear to be ideal places for massive infections with hookworm. The average number of hookworms per patient in the southern United States is stated to be twenty, but in Porto Rico it is one thousand.[1] Hence the very severe type of anemia

[1] Colonel Ashford. Personal communication.

which prevails in the country districts and almost totally disables the affected individuals for manual labor. On the other hand, judging from analogy, it is to be expected that an old settled community will have a fairly complete tuberculization. An extended survey here by means of the tuberculin cutaneous test would certainly furnish very interesting and valuable results.

Though in many respects the data furnished are defective, the foregoing examples of communities, civilized and semi-civilized, in which tuberculosis has long prevailed afford some idea as to the type of the disease which may be expected. In all the prevailing type is chronic pulmonary tuberculosis which may pursue a very sluggish course; tuberculosis of bones, joints and glands, chronic conditions, occur with more or less frequency. The morbidity is evidently often high, the rate of mortality, as a rule undetermined and no doubt undesirably high, is apparently not alarming. Where statistics are available it appears that improvement in sanitation effects a lowering in the mortality from tuberculosis.

CHAPTER IV

NON-TUBERCULIZED RACES

Very different is the picture when the natives of a tropical country first come into contact with an older civilization.

Buisson[1] says of the Marquesas: "Tuberculosis is now very widespread. It has depopulated many valleys. It evolves with great rapidity. When the malady attacks one of the unhealthful huts where swarm pellmell eight or ten, even twelve or fifteen persons, it is quickly emptied. In less than two years, sometimes in one year, the house is vacant — all of its inhabitants are in the cemetery. The population has considerably diminished and will soon disappear, if a remedy is not found". Robert Louis Stevenson[2] says: "The Marquesan race is perhaps the handsomest extant. Six feet is about the middle height of males; they are strongly muscled, free from fat, swift in action, graceful in repose. To judge by the eye, there is no race more viable; and yet death reaps them with both hands. When Bishop Dordillon first came to Tai-o-hae, he reckoned the inhabitants at many thousands; he was but newly dead, and in the same bay Stanislao Moanatini counted on his fingers eight residual natives. The tribe of Hapaa is said to have numbered some four hundred, when the small-pox came and reduced them by one-fourth. Six months later a woman developed tubercular consumption; the disease spread like a fire about the valley, and in less than a year two survivors, a man and a woman, fled from that new-created solitude. A similar Adam and Eve may

[1] Ann. d'Hyg. et Méd. Colon. Vol. 6, 1903, p. 535.
[2] In the South Seas. 1908, p. 33.

some day wither among new races, the tragic residue of Britain. When I first heard this story the date staggered me; but I am now inclined to think it possible. Early in the year of my visit, for example, or late the year before, a first case of phthisis appeared in a household of seventeen persons, and by the month of August, when the tale was told me, one soul survived, and that was a boy who had been absent at his schooling".

Similarly McCarthy reports from Panama that tuberculosis plays havoc there with the mixed tropical races, whole families being sometimes infected simultaneously in their unhealthful huts to the complete extermination of groups of natives.[1] From the German West Carolinas it is reported that Yap is being depopulated by tuberculosis.[2] A census shows that the older people are in the majority, some of the years of youth not being represented at all. The young people have melted away in the last few years with tuberculosis, having also been carried off in part with dysentery. Here, however, the tuberculosis was not strictly primary, otherwise there would have been no distinction as to the age of the victims.

According to Calmette,[3] an English speculator once introduced into Lima 2000 natives of the Marquesas. Three-fourths of these were dead of tuberculosis in less than 18 months.

In 1803 and 1810 the British government imported some three or four thousand negroes from Mozambique into Ceylon to form regiments. Of these there were left in 1820 but 440, including male descendants. Bartolocci, according to Hirsch, says that 9000 Kaffirs brought to Ceylon

[1] Boston Med. and Surg. Jour. Vol. 166, 1912, p. 207.
[2] Mayer, loc. cit.
[3] Ann. de l'Institut Pasteur. Vol. 26, 1912, p. 207.

by the Dutch government and put into military service, left no trace by which their descendants can be recognized in the present population.[1]

In Queensland the mortality of the whites from tuberculosis is low, notwithstanding the fact that consumptives from England resort there on account of the favorable climate. Yet according to Jeanselme and Rist, tuberculosis is murderous among the Polynesians, who, while they make up but two per cent. of the population, furnish twenty-two per cent. of the mortality from tuberculosis.

From an account by a physician published in 1910[2] it appears that the island of Tierra del Fuego, until about 30 years before the article was written, was inhabited exclusively by native Indians. The discovery of gold and later sheep-farming, brought Europeans, mostly English, to the island. Although the Indians possessed no fire-arms, they nevertheless attempted to resist the encroachments of the whites, and many of them were killed in the unequal strife. But in addition to losses in warfare the Indians perished in large numbers in part from syphilis and alcohol, but the greater number from tuberculosis.

A Catholic order was given the use of a small uninhabited island by the Chilian government with a view to "Christianize" the natives of Tierra del Fuego there and to put an end to the ceaseless combats. So far as the Indians could be laid hold of they were transported to this island, the number sent being estimated at about 2000. Here they were put to work on a sheepfarm, were compelled to wear European clothing, and were crowded into ill ventilated huts. The result was devastation by tuberculosis.

[1] Handbuch der Historisch-geographischen Pathologie. Vol. 2, 1862-1864, p. 74.

[2] "Dr. D.", Münch. Med. Wochenschr. Vol. 1, 1910, p. 1075.

In three years only a few dozen Indians remained alive. A priest relates that of about 200 captured Indians, 48 died of tuberculosis in a single month. The writer remarks that it is no exaggeration to say that every native Tierra del Fuegan who comes permanently in contact with the whites dies of pulmonary tuberculosis, and says that the course of the tuberculosis is extraordinarily rapid. "When the first certain signs of the disease are found in the lungs it may safely be assumed that the patient will die within six weeks". The total number of Indians was estimated at 5000 when white men first settled upon the island. Of these barely 300 remained in 1910. It is probable that the race will soon become extinct. Tuberculosis does not occur among the whites more frequently than in Europe, and is of the usual type. The climate, though harsh, seems to be a healthful one for Europeans. The natives say that before the whites arrived old age was the only cause of death.

The foregoing facts illustrate the terrible effects of tuberculosis when large numbers of the unprotected are subjected to massive infections, especially when under bad hygienic conditions, the disease then prevailing as an epidemic and sweeping off nearly every one who has been exposed to it.[1]

Unless the race is exterminated, however, it undergoes a process of tuberculization through decades or centuries, the disease becoming gradually more chronic and less severe, until finally under favorable conditions a stage of immunization is reached comparable to that which prevails in the most highly civilized peoples. American Samoa seems to be a case in point. In Tahite and Hawaii also the formerly acutely fatal types of tuberculosis have largely disappeared, as the tuberculization of the people has become more complete.

[1] Compare also pages 75, 109, 160, 162, 165 and 167.

CHAPTER V

MODES OF INFECTION

It is customary to attempt to explain tuberculous infection by contact with the consumptive, but there are so many cases in which the history gives no assistance whatever in pointing out the source of the infection that it is evident that we must look beyond immediate contact with cases of open tuberculosis or their infected surroundings, to account for the practically universal dissemination of the tubercle bacillus under the conditions of civilization. Experience shows that children who live with a consumptive are likely to have a more severe form of tuberculous infection than that of those whose sources of infection are unknown. This may be explained, no doubt, in part at least, by the supposition that the latter receive a smaller amount of the infectious organisms, but it is by no means improbable that attenuation of the tubercle bacilli also plays a role here. It should be remembered that the tubercle bacilli retains its vitality almost indefinitely if not exposed to direct sunlight, but that its virulence is somewhat reduced by dessication. There is always the chance that the living bacillus may reach the hands and, secondarily, too often the mouth of the uninfected child from some article in common use that has been touched by the infected hands of the consumptive (or the tuberculosis carrier). Some of such articles which are practically never disinfected are wooden toys, books (especially of schools and public libraries), shoes, and other articles of leather, clothing, coins and bills, bread, cake and candy from the shops, the paper and string used for wrapping parcels, postage stamps (laid face up

upon a possibly infected counter without regard to the fact that their adhesive surface is admirably adapted to pick up germs of disease), letters received through the mails (both envelopes and contents), the doorknobs of public buildings, the handrails of trolley and steam cars, dust from the street deposited on the floor and adhering to dropped articles, etc., etc. When we consider that in order that infection may take place, it is only necessary that the mouth shall have been contaminated once in the course of years from one of the articles above enumerated, some or all of which are handled every day by most people, it would appear that infection could hardly be escaped.

But there is another possible source of infection which is rarely taken into consideration. Calmette,[1] basing his ideas upon the results of his extensive experiments with cattle, claims that since, as he has shown, tubercle bacilli which circulate in the blood of tuberculous cattle are eliminated with the bile by the way of the intestine, it is altogether probable that the bacilli of human tuberculosis are eliminated in the same manner. It has been shown that bacteremia may be present in cases not clinically tuberculous and it is also known that tubercle bacilli may be found in the faeces in cases of tuberculous disease of the bones or joints, the lungs and alimentary canal being free, so far as can be determined during life, of tuberculosis. The subject requires farther investigation, no doubt, but the probabilities are in favor of the assumption that every individual who harbors tubercle bacilli is a tuberculosis carrier who may at times excrete tubercle bacilli by way of the intestine. We know what it means to the household if the cook is a typhoid-carrier, and what extreme care is necessary for the safe disinfection of the hands of those who have to do with

[1] Loc. cit.

typhoid fever. Such care is naturally never taken by the tuberculosis-carrier, who regards himself as a healthy person. If those "vaccinated" against tuberculosis are tuberculosis-carriers, the fact which puzzles some writers is explained, namely that though no cases of open tuberculosis are present, contact on the part of the unprotected savage with Europeans, Hindoos or Chinese sooner or later leads to infection with tuberculosis.

With regard to the possibility of the infection of tuberculosis being communicated to others by those who apparently were without disease at the time, there is an interesting analogy in leprosy. Speaking of the long incubation period of that disease, Babes says: "We would only insist that the peculiar febrile phenomena and eruptions which precede the true disease, often by many years, speak for the fact that the bacillus does not remain entirely inactive, but increases in number from time to time and probably produces fever-making substances. I have also been able to make out that sometimes certain deep lymph-glands may show changes many years old, evidently much older than the manifest leprosy. One can not reject the idea that even in this stage, under some circumstances, infection can result for there are cases in which it is stated that individuals have become leprous who had been in contact with others who came from lepra-regions but without being leprous, the disease not manifesting itself in these latter until a later time".[1]

The practice among civilized peoples of handling constantly many objects which have passed through unknown hands has, then, the advantage that it tends to facilitate infection with tuberculosis by means of comparatively few

[1] Die Lepra, Nothnagel's Spezielle Pathologie u. Therapie. Vol. 24, p. 58.

bacilli attenuated by drying and age. The uncivilized eat out of a common dish, pass the tobacco pipe from hand to hand, lie down at night in close contact on ground fouled with expectoration. The conditions are ideal for the further propagation of tuberculosis, once it is introduced, hence, in part, the epidemic character of the disease. On the other hand the tropical native makes much less use of articles of commerce than the civilized. He is not so likely, therefore, to get his primary infection from a few attenuated bacilli. Living in a narrow circle he may long escape infection altogether, but when it comes, it will probably have been derived from personal contact of some kind and will, therefore, be more massive and more virulent. But no doubt the unprotected adult may and often does obtain a " vaccination " from his first infection.

With reference especially to the question as to the possibility of immunizing the unprotected adult by means of his first infection, the experience of Much in Jerusalem and the conclusions that he draws from it are of interest. They also corroborate in a helpful way the lessons derived from the study of tropical tuberculosis.

Much made an investigation of the tuberculosis situation in Jerusalem and tested many of the inhabitants by means of the cutaneous reaction to tuberculin. He draws his conclusions as follows:[1]

" If we test people who have recently come from Yemen, we find that those born in Arabia react negatively, but the case is quite different with those who have lived some time in Jerusalem. Here we found positive reactions in almost 90 per cent. and beginning, even, in earliest childhood. Those who react almost always have some (manifest) tuberculous

[1] Beitr. z. Klinik d. Tub. Sixth Supplementary Vol., p. 25.

affection in contrast with the positively reacting Jews of other races and the Europeans. Thus it is explained why in the Yemenites the disease is a pestilence, which is not the case in the European Jews, who react positively in a high percentage. The explanation is the same as has been given for the appearance of the disease as an epidemic in all races and regions hitherto free of tuberculosis. In Europe, tuberculosis is a child's disease. Almost every European receives tubercle bacilli in childhood and is thereby either infected or immunized. The adult is protected against a second infection coming from without. If he dies it is from the disease of childhood, i. e., from the tubercle bacilli acquired when a child. For the Jews from Europe the conditions in Palestine are similar. With the Yemenites and all the sub-races which come from regions free of tuberculosis the case is different. They are in the greatest danger, and this is true also of the Arabs. With them tuberculosis is not a child's disease. There has been no contact with tuberculosis, therefore no immunization. There the adult is in the same condition as the not yet immunized child. The question why the immigrating adult can not immunize himself as the child does in Europe is probably to be answered by saying that he, going about freely, always comes in contact with large amounts of tubercle bacilli which can not be resisted, while the child is limited in his movements."

We see here again that, as was the case with the Polynesian, it is not a question of racial susceptibility or immunity.[1] The Jews generally show great resistance to tuberculosis, yet the Jews born in Arabia have no defense against the disease. For them tuberculosis is "pestilential," be-

[1] According to some authorities, however, the Jews of Yemen are racially Arabs who have adopted Judaism. (Fishberg, The Jews, p. 124.)

cause they have had no opportunity to develop an immunity before coming into contact with massive infections.

Antenatal infection being extremely rare, it may be assumed that the human infant begins life free of tuberculosis. The world of the very young infant is a narrow one. Its fate as to tuberculosis rests in the hands of the mother. The conditions are such that if tuberculous infection takes place at all, as when the mother is consumptive, the dosage will probably be large and the child will be likely to die of an acute generalized tuberculosis. If the child escapes such a fate it will probably not be infected until it is old enough to move about. With cleanly surroundings and in the absence of opportunities for direct infection from consumptives, the child will pick up now and then a tubercle bacillus from some of the countless articles which come within its reach that may be infected. These bacilli reach the glands through the various portals of infection and there are collected and very possibly also increased by multiplication until the threshold of infection is reached, i. e., until the number is sufficient to arouse the specific resistance of the organism. The bacilli, coming in one by one, in this manner, the threshold of infection will be passed by the smallest number of bacilli that can excite a reaction. The child thus infected, if shielded from massive reinfecting doses, will proceed to develop an immunity which in time reaches a maturity such that no subsequent infection from without can take hold. He may go through a long life without developing any manifest tuberculous disease, though, perhaps, repeatedly exposed to infection.

It should be emphasized that a history of this kind is the history of the majority of civilized adults. But if the initial infection has been large or if there have been repeated early reinfections or if the resistance of the individual is

lowered by intercurrent disease or by bad hygiene, the infection with tuberculosis is no longer simply a beneficent vaccination but is in truth an infection.

On account of the bad hygienic conditions in which the tropical native lives he is more likely to receive a too large initial infection than the more civilized inhabitants of the temperate zone.

When such an entirely unprotected organism, whether infant or adult, is subjected to infection from large amounts of tubercle bacilli, the result is a generalized and acute disease the duration of which is measured by months instead of by years or decades, as in the preceding types. There is a certain period of incubation — time is required for the multiplication of the invading bacilli — there is even some resistance, for certain evidences of attempted localization may be detected, but no immunity worthy of the name. While in chronic tuberculosis the immunity present effects characteristic localizations of tuberculous lesions, as the result of a more or less successful resistance to the growth and extension of the tubercle bacillus, the absence of effective resistance in primary tuberculosis permits extremely varied forms of tuberculous disease the nature of which, as found at autopsy in the individual case, is probably largely dependent upon the size and number of the primary infections and their portals of entry.

CHAPTER VI

PATHOLOGY AND PATHOLOGICAL ANATOMY

Immunity is the name given to the increased resistance of the tuberculous subject which is acquired in the course of his struggle with the tubercle bacillus. Practically absent when the infection has been overwhelming, the immunity becomes very marked in the small infection in which the organism of the individual has had time to perfect its defenses. Aside, then, from the hopelessly acute infections, the study of the course of the tuberculous process is really a study of the defensive warfare of the human organism, the tubercle bacilli being a constant quantity in the sense that, while they may vary in virulence, such variations are due to increase or diminution in the resistance to which they are subjected. We sometimes speak, rather loosely, of immunization against tuberculosis as a vaccination. The process bears a certain resemblance to vaccination against smallpox, but in some important respects it differs from it. In the first place, vaccination is the inoculation of a virus derived from and similar to but not indentical with that of smallpox, but as yet all efforts to produce a permanent and efficient protection against tuberculosis by the use of allied bacilli, or the products of the tubercle bacillus have been failures. Protection against tuberculosis can only be obtained from infection with virulent tubercle bacilli — the subject must become tuberculous in order to resist tuberculosis! In the second place, the infection is a continuing infection; resistance must always be active, or must be ready to be active, for the reason that the tubercle bacillus is one of the most resistant of bacteria and, once it has

entered the body, never, as a rule, becomes extinct. Whereas, in smallpox vaccination the virus, so far as we know, does not continue to live, so that the effect of the vaccination, profound at the outset, gradually diminishes and must be repeated from time to time in order that protection may be assured. Vaccination against tuberculosis is therefore more efficient than vaccination against smallpox because it is a continuing vaccination which persists through the life of the individual vaccinated. If the foregoing is correct, does it not necessarily follow that the subject who is so constantly on the alert to resist his own bacilli will also be able to resist tubercle bacilli which may enter his body from without, that one is protected against reinfection from any source outside his body who is successfully resisting reinfection from the countless foes within? Of course, when worn out with the long contest the spread of the disease is no longer opposed by the tuberculous patient, he may be susceptible to outside infection, but then the fact is immaterial — the fatal issue will hardly thereby be hastened. The infection with tuberculosis differs again from vaccination against smallpox in the important particular that being a continuing infection, it is always ready to take advantage of a temporary weakness of its opponent to spread more widely, perhaps fatally. The fact that the individual who is immunized against tuberculosis may, nevertheless, die of his disease leads many to deny the existence of an immunity in tuberculosis. But the fact that resistance may be overcome is not a proof that it does not exist. It has been shown that tubercle bacilli circulate in the blood from time to time in many, if not in all, cases of tuberculosis, but without, as a rule, infecting parts away from the existing lesions. There is, then, what may be called an immunity against circulating tubercle bacilli in

all cases of chronic tuberculous infection until a complete breakdown occurs, as shortly before death from tuberculosis. Thus only is that localization of the tuberculous process possible which is so important a feature in the more chronic types of tuberculosis. But it is quite conceivable that the patient may be able to restrain the development of new foci at a distance, but not capable of preventing the growth of large existing lesions. That is, the immunity may be sufficient to overcome scattered foes, but not to cope with large numbers of the enemy when aggregated.

Or, to put it in still another way, the immunity of tissues at a distance may be perfect against invading tubercle bacilli, but tissues more or less surrounded by colonies of tubercle bacilli and by accumulations of their poisonous products may in time be hopelessly poisoned. At a distance from the lesion antibodies predominate; about the lesion they are outnumbered.

The tubercle bacilli that enter the blood are dispersed throughout the body — acute miliary tuberculosis is hematogenous. On the other hand, the lymphatic system is the collecting agency for bacteria from the blood as well as for those that enter the body from without. Moreover the sluggish flow in the lymph vessels favors the accumulation of the poisonous products of the tubercle bacillus. Hence we find that the extensions in localized tuberculosis are usually lymphogenous and, at first at least, develop in the vicinity of large collections of tuberculous poison — either large old tuberculous foci of the parenchyma, or caseated glands.

It follows, then, that the prognosis in tuberculosis will be the more unfavorable the greater the amount of tuberculous tissue present in the given case. A mature immunity will as a rule be high and easily maintained if the tubercu-

lous foci present are small in size and few in number, but exceptionally immunity appears to be totally lost from unknown causes though the tuberculous lesions are small.

We recognize two degrees of immunity in tuberculosis: First, immunity against the tubercle bacillus — tuberculous bacteriemia does not create new foci. Second, immunity against tubercle bacilli and accumulations of their poisonous products, an immunity which is maintained with difficulty in the presence of large tuberculous foci.

Primary tuberculosis is seen with us practically only in young children. It was formerly held that infection at this age is always fatal, but this is far from being true. As has been shown by tuberculin reactions, a considerable percentage of young children go on to develop an immunity as the result of the early inoculation and may never exhibit any manifestations of clinically apparent tuberculosis. In such cases we may infer from analogy with the results of experimentation with animals that the dosage of the infectious agent has been small and that the native resistance has been sufficient to prevent early and rapid multiplication of the infecting bacilli. As a result of the almost instantaneous reaction to the new poison, the lymph-glands as well as the other tissues acquire at first an increased activity which in time becomes an insensitiveness to tuberculous infection whether exogenous or endogenous, so that reinfections produce, according to the dosage, either no visible lesion or one that heals. The fundamental distinction between primary and secondary tuberculosis is that in the latter the glands do not swell. The child which has received a tuberculous infection of the nature of a vaccination against the disease never has any marked swelling of newly involved lymph-glands whatever its subsequent history as respects tuberculosis may be.

If the initial dosage is larger, the tuberculosis of the glands advances more rapidly for a time than the immunization of the tissues, with the result that the lymph-glands swell to a certain extent and become more or less caseous. There is a great variety of possibilities as respects the extension through the lymphatic system of this type of tuberculosis, as Harbitz[1] has shown. The disease is more severe than in the first type, the caseations present are a constant menace and there may be involvement of various viscera, bones and joints according to the location of the most seriously affected lymph-glands, but still the course of the disease is chronic and it is not necessarily incompatible with a very considerable duration of life.

If the initial dose is still larger, or if native resistance is low, or if both unfavorable factors are present, the glands become greatly swollen, caseate and suppurate with early overflow upon the viscera, resulting in acute and fatal disease.

As respects the implication of the lymph-gland system we may distinguish three types of tuberculosis: First, the small infection in which there is no considerable swelling and only minimal caseation of lymph-glands — the infection of immunization.

Second, the type of chronic generalization in the lymph-gland system, the tuberculosis which is sometimes called scrofula, in which there is more or less extensive caseation of lymph-glands — the infection of imperfect immunization.

Third, acute generalization of tuberculosis in the lymph-gland system in which there is no immunity.

In the first type there is either no manifest tuberculosis at all, or if manifest disease declares itself the form will be that of chronic phthisis. In the second the disease may

[1] Häufigkeit u. Lokalisation d. Tuberkulose, etc., Christiana, 1905.

manifest itself in a variety of forms in childhood — bone and joint tuberculosis and the like — but in many cases the termination is in chronic pulmonary tuberculosis in adult life. It is particularly important to note that though the first and second types are those of chronic disease and are spoken of as later forms of tuberculosis, yet the fact that they are later in appearance and chronic in course does not prove that the primary infection was of later date than one which has resulted in actual fatal disease. These two types, in other words, are to be regarded as manifestations of the reaction of more or less immunized organisms to an enemy which they are not able to subdue without a struggle, the ability to develop a resistance being rendered possible by the fact that the original infection was not an overwhelming one.

The fate of the individual as respects tuberculosis depends therefore throughout life very largely upon the nature of his original infection.

The feature which distinguishes primary tuberculosis from the later forms is that as a manifest organic disease which has passed beyond the limits of the lymph-gland system it is invariably fatal. The alternative for the young child is immunization or death from generalized tuberculosis.

The same is true of primary tuberculosis in the adult. He also may become immunized by a small infection, but if manifest tuberculosis declares itself within a brief period after infection he will quickly die.

Fraenkel[1] states that the peculiarities of its course justify the consideration of the tuberculosis of early childhood (to the 5th to 7th year of life) separately from that of later youth. He distinguishes two types: (1) Generalized

[1] Pathologie und Therapie der Lungenkrankheiten, p. 761.

chronic tuberculosis, sometimes afebrile or with remitting or hectic fever. Here there is an increasing cachexia-like atrophy, almost constant swelling of spleen and liver, moderate swelling of numerous lymph-glands, cervical, occipital and inguinal. Tuberculosis meningitis is often the only sign of tuberculosis except the emaciation. Yet at autopsy almost always extensive lesions of the most various organs (especially, besides the lungs, the liver, spleen, and bronchial and abdominal lymph-glands) are found, sometimes as large conglomerate tubercles, sometimes as miliary foci. (2) Acute and subacute miliary tuberculosis. This is generalized like the other form but the sudden irruption of numerous tubercle bacilli into the circulation and the development of massive nodules in the internal organs produces a more stormy course. Fever is rarely absent. In some cases general symptoms predominate. There is a typhoid condition with great prostration, swelling of abdomen, delirium, dyspnoea, cyanosis and death in one to three weeks. Tropical writers describe cases with similar course among the adult natives. Perhaps the most vivid description is that of Woods Hutchinson, who writes of tuberculosis as it affects the Indian population of the Pacific northwest and describes what is evidently primary tuberculosis. He says:[1]

"I could hardly believe my ears when some of the agency physicians assured me that they had seen adult braves die in three weeks of tuberculosis. All united in the statement that the disease usually ran its course in about nine months in adults, seldom extending beyond a year, and, taking children into consideration, the average duration of the disease from start to fatal termination would not average much more than four to six months. Moreover those who

[1] N. Y. Med. Jour. Vol. 86, 1907, pp. 624 and 671.

went into details described a new and curiously uniform type of the disease, beginning with fatigue, shortness of breath, pallor or blueness of lips, rapid pulse and frequently subnormal temperature, with exceedingly rapid consolidation of the lungs, beginning with the apices. The patients would lose weight with frightful rapidity, fall into a muttering delirium and die of heart failure, much as in septic pneumonia or in typhoid. Nearly all of them also had been struck with the large amount of glandular tuberculosis both in the fatal cases and in the survivors."

Tuberculosis changes found at autopsy are of three general types: the tuberculosis of the more or less well-immunized individual, the tuberculosis of the imperfectly immunized individual and primary tuberculosis in which there is little or no immunity.

1. a) Tuberculosis the cause or the accessory cause of death. The more or less well-immunized subject presents the characteristics of chronic phthisis as it is found in the temperate zones — a slowly progressive disease long limited to the lungs and with a marked tendency to localization and repair, characterized by the presence of abundant firm fibrous tissue, especially in the upper lobes and about the hilus, with or without cavities. Early extensions are usually in the form of a few large conglomerate tubercles, later extensions appearing as wider disseminations of more numerous and smaller tubercles, peribronchial and bronchial tuberculosis, or as hematogenous miliary tubercles. Or the later tuberculosis may manifest itself as an invasion of the parenchyma by lobar pneumonia or broncho-pneumonia, terminating in extensive caseations. When death occurs from tuberculosis, the immunity disappears as a rule before death, with the result that there is a general dissemination

of tubercle bacilli throughout the body. If life is sufficiently prolonged, these may lead to the formation of numerous macroscopic miliary tubercles. More usually, however, the foci are determinable only by the microscope. Large conglomerate tubercles are rarely seen in the liver and spleen, but smaller foci of hematogenous origin, often fibrous or calcified, may be found in spleen, kidney, and, more rarely, in the liver. Microscopic tubercle of liver and spleen are, however, usually present as the result of the antemortem invasion of tubercle bacilli.

However completely the subject may have lost his original immunity before death, the fact that it has existed is shown by the presence of fibrous tissue and the amount of this fibrous tissue constitutes the best evidence of the degree of resistance that has been attained during the course of the disease. Cavity has been regarded as a sign of immunity but this is true only of the cavity which is encapsulated with fibrous tissue. It is not the presence of a large broken-down focus which constitutes a sign of immunity but the thick fibrous walls by which said focus has been enclosed. A further evidence of immunity is the absence of much enlarged lymph-glands in the thorax and elsewhere. A primary tuberculous focus is regularly accompanied by a well-marked adenitis of the regional lymph-glands. The most usual extra-thoracic extensions of tuberculosis in the fairly immunized subject are as tuberculous laryngitis and enteritis. Characteristic of the secondary nature of these complications is the absence of swelling of regional glands, or if the glands swell, as is more often the case in tuberculosis of the intestine than in that of the larynx, the swelling is slight in comparision with that seen in primary tuberculosis.

b) Tuberculosis is discovered after death from another

cause. Fibrous or calcified tubercle, adhesions of the pleura, localized fibrous thickenings and small, dry cavities of the apex or upper part of the upper lobe speak for the existence of a healed tuberculosis, and hence of an immunity. Other evidence is furnished by small calcified or fibrous foci of the lung parenchyma, and fibrous and indurated peribronchial and hilus lymphatic glands. Large caseated glands are not found in this type of tuberculosis.

In the study of the epidemiology of tropical tuberculosis no opportunity should be lost to search for these evidences of an early tuberculous infection. They are discovered if persistently sought for in the large majority of the autopsies of civilized man. The percentage in which they are to be found in the tropics is important evidence of the degree of tuberculization of the community. In eight deaths from tuberculosis of negroes of Kamerun, Löhlein[1] found evidences of old, more or less cured tuberculous infection in but one. Here the bronchial glands contained some old calcified nodules and there was extensive adhesive pleurisy. But of fifteen adult Hottentots, four (26.6 per cent.) showed old processes of slight extent in lungs and bronchial glands. McCarthy[2] reports that in over six hundred autopsies at Panama of West Indian negroes, he observed but one healed tuberculosis where the focus was of any considerable size, but saw a few cases among American negroes where cicatricial tissue had replaced tuberculous foci to a considerable extent. In most cases, among the West Indians, the tuberculosis of the lungs took the form of caseous bronchopneumonia, with rarely any attempt at repair. Among the natives of Batavia benign types are frequent and at autopsy old tuberculous foci are found in

[1] Archiv f. Schiffs-u. Tropenhyg. Vol. 16, 1912, Beiheft 9, p. 18.
[2] Loc. cit.

the lungs in about one-half of the cases in which tuberculosis was not the cause of death. But in the country districts of Java, where tuberculosis is rare but very fatal, evidences of previous infection are rarely seen after death.

2. The tuberculosis of the imperfectly immunized individual. The relative absence of immunity is shown by chronic enlargement of lymph-glands. When the initial infection is small and the health of the subject is good, the processes of immunization advance so rapidly that the lymph-glands become insensitive to the tuberculous poison at an early period, as do the other tissues of the body, hence they never swell so as to become clinically recognizable. Such swelling as may be found at autopsy, though representing a considerable increase over the very small normal size of the glands, is not large in the clinical sense. The glands are not caseated (though occasionally miliary tubercles are seen in them as the result of the ante-mortem bacteremia) and are indurated from fibrous changes. Whereas in the class now under consideration, whether because the initial infection has been too large, because it has been often repeated before immunization has developed, or because the health of the individual has not sufficed to restrain multiplication of the bacilli, the glands are more seriously infected, swell considerably and become caseous. One group of glands, as the cervical or the hilus glands, may alone be affected or the chief gland groups of the body cavities may all be involved to a greater or less extent. Besides the cervical and thoracic glands, the most important groups are the portal glands, the glands about the head of the pancreas, the aortic glands at the hilus of the kidney, the mesenteric glands and the iliac and inguinal glands. A massive primary infection soon leaves the glandular system to invade the parenchyma

of neighboring organs, as when tuberculosis of the tracheobronchial glands extends to become pulmonary tuberculosis. But in some instances the disease, having originally a slower rate of progression, remains long confined to the lymphatic system and may in the end attack by direct lymphogenous extension any of the organs, the lungs chiefly, but also kidneys, intestine, peritoneum, genitals, etc. Tuberculosis of the skin (tuberculides), eye, bones and joints is characteristic of this type, the joints and the spinal vertebrae being especially exposed to attack by direct extension on account of the proximity of important glands. In the more chronic forms of this type there is usually some evidence of proliferation of fibrous tissue.

3. Primary tuberculosis. As it appears in the young child, a massive tuberculous infection results in a generalized tuberculosis very different from the chronic lung disease of the adult. "The course of tuberculosis," says Heineman of the Javanese laborers in Sumatra, "is, unlike that of Europe, a very severe acute or subacute disease which in its tendency to generalization resembles that of the earliest childhood in Europe".[1] In fact the experience in the tropics with adults shows that the peculiarities of the tuberculosis of the earliest years, as we know it, are not due to the age of the child but to the absence of an immunity from previous infection. There is a great variety of manifestations of primary tuberculosis. Some forms found even under civilized conditions, that give little evidence of resistance, have probably been previously exposed to infection and are not, speaking strictly, primary cases. This class shades into the preceding, from which it is distinguished by its acute course and early onset after infection. The most characteristic feature of primary tuberculosis is general

[1] Hamburgische Med. Ueberseehefte. Vol. 1, 1914, p. 34.

implication of the lymph-glands, not in a chronic form as in the imperfectly immunized, but manifesting itself often as great packets of enormously enlarged caseated and suppurating glands. Some observers report large caseous masses in nearly every case autopsied.[1] Mouchet[2] in the Belgian Congo in 31 autopsies saw 12 cases of miliary tuberculosis. In all of these with one exception there were great caseated glandular foci most frequent in the hilus or mediastinum, but also found in the mesentery or in front of the spine. The lungs are very frequently involved, predominatingly as caseous bronchopneumonia or caseous lobar pneumonia. In fifty per cent. of cases of pulmonary tuberculosis, Mouchet saw a yellowish oedematous infiltration of the lung, " gelatinous " pneumonia. The lungs may also be filled with miliary tubercles, usually as a part of generalized miliary tuberculosis. A significant fact is that there is no evidence of attempt at repair by the proliferation of fibrous tissue.

Another characteristic manifestation is the primary involvement of serous membrances. Pleura, pericardium and peritoneum may be implicated in the same subject — the disease is a tuberculous serositis. Tuberculosis of serous membranes may present itself as disseminated miliary tubercles, or as massive caseations, or as fungoid tuberculous granulations making mushroom-like growths. Pleural adhesions are often absent and rarely extensive. Effusion occurs in practically all cases in which the pleura is not adherent. Sometimes in place of fibrinous exudate the pleura is coated with a voluminous lardaceous substance. The liver and spleen may be attacked by tuberculosis in the

[1] A district surgeon says of Natal and Zululand: " There is an exceeding prevalence of large glandular masses". So. African Med. Rec. Vol. 13, 1915, p. 139.

[2] Bull. Soc. Path. Exot. Vol. 6, 1913, p. 11.

form of perihepatitis and perisplenitis, but large conglomerate tubercles are found in them as well as in the kidney. Very characteristic of primary tuberculosis are caseous tubercles of the myocardium and the pericardium. In 452 autopsies of West Indian negroes in the Panama Canal Zone Clark[1] saw large caseous nodules of the myocardium 15 times, tuberculous mural endocarditis 6 times and tuberculous pericarditis 62 times. He had several cases in which the only extensive focus outside of the glands was in the heart. He also reports tuberculosis of the spleen 263 times, of the liver 238 times and of the kidney 193 times in the same group. Intestinal tuberculosis differs from the familiar type by the presence of enormously enlarged caseous mesenteric glands. The intestinal ulcers may be more acute, their bases may be engorged with blood.

Although much in the above description strongly suggests bovine tuberculosis, it is certain that little or no infection from cattle occurs in the tropics. Milk does not, as a rule, constitute a part of the food of the native and infants are usually suckled by their mothers.

Often cases of primary tuberculosis are found associated with others that furnish evidence of a higher resistance. The mixed population of a large city will never be entirely composed either of highly immunized nor of unprotected individuals.

The experience of Westenhoeffer[2] in Chile, and of Deycke[3] in Turkey are the more valuable because not having been gathered in the tropics it illustrates the fact that the peculiarities of tropical tuberculosis are not due to the geographical location but to the absence of protection from previous infection.

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[1] Am. Jour. Trop. Dis. and Prev. Med. Vol. 3, 1915–1916, p. 331.
[2] Berl. Klin. Wochenschr. 1911, p. 2063.
[3] Beitr. z. Klinik d. Tub. Fourth Supplementary Vol., p. 60.

Westenhoeffer states that of 48 cases of pulmonary tuberculosis which had led to death there were only 28 which permitted the assumption of a chronic course and even in these there was in general an absence of a tendency to connective tissue formation and cavitation. On the other hand 17 cases did not give the picture of chronic tuberculosis. The majority were extensive confluent, cheesy pneumonias, in some cases involving entire lobes. In many of these cases the pleura was destitute of old fibrous adhesions and thickenings being simply clouded and in spots covered with a thin fibrinous deposit. The bronchial lymph-glands in the majority of cases showed a succulent swelling with fresh caseations, only rarely indurative conditions or old caseations. In at least one-third of Westenhoeffer's cases the disease was quite acute, as would be anticipated, he says, when patients are attacked by tuberculosis who are not in the least immunized by precedent mild infections. The high number of secondary intestinal affections (more than one-half of the cases) as well as the other extensions of tuberculosis and the relatively high number of conglomerate tubercles in adults favor the same view. Tuberculosis in Chile appears preponderatingly as an acute infectious disease which destroys as many lives proportionately to population as in Europe, but at the most, one-half as many proportionately are sick with it.

Deycke, at a military hospital and medical school in Constantinople, to which came students from the entire Turkish Empire, had a similar experience. He says:

" The picture of ulcerating phthisis with its beginning in the apices and the slow extension of the process to the other parts of the lungs, its chronic course with its temporary improvements and deteriorations, the strongly marked tendency to mixed infections, to cavernous breaking down

of the tissues — all this is seen not rarely in Turkey, but it does not dominate the pathology of tuberculosis in the same degree as with us. Here in this hospital, going from bed to bed, I see the monotonous picture of chronic pulmonary tuberculosis which it is not necessary to describe. In Turkey the picture was much more changeful. Predominating were the dry forms of pulmonary tuberculosis, i. e., disseminated miliary tuberculosis, cheesy peribronchitis and bronchial pnuemonia and cheesy lobar pneumonia. The tendency to breaking down was relatively slight, partly perhaps for the reason that oftener than with us one had to do with true tuberculosis without mixed infection, hence clinically dry sounds, bronchial breathing, dullness, etc., were more frequent than moist and resonant rales and amphoric breathing and the like and not infrequently the physical findings were greatly disproportionate to the bad general condition of the patient and the extent of the lesions as found later at autopsy. To be able to demonstrate true clinical cavity signs was often impracticable in spite of a large number of tuberculous patients. It was comparatively rare that I could demonstrate elastic fibres in the sputum, though I searched for them often enough, but from this it must not be supposed that tuberculosis of the lungs in the absence of the tendency to breaking down ran a more benign course than with us. Quite the contrary. I very soon gained the impression that the disease extended in general more rapidly than with us and not rarely appeared under the form of an acute or subacute infectious disease with high fever and rapid loss of strength.

"A form of tuberculosis which appears relatively often in Turkey is primary tuberculosis of the serous membranes. Not only pleurisy but also tuberculous peritonitis are fre-

quent diseases in Turkey, not in the form of secondary infections of pleura or peritoneum but as primary diseases without implication of the lung or of the intestine. Among such cases also the number of so-called dry forms in relatively large. One sees with unusual frequency nodular tuberculosis of the pleura and of the peritoneum, the two being usually associated with one another so that one would have to speak of a polyserositis tuberculosa especially as the pericardium also is frequently attacked. One finds an obliterating pleurisy where the former pleural cavity is replaced by fibrinous or even fibrous thickenings some centimeters in thickness, interspersed by great, flat caseous nodes. In the abdominal cavity an analogous caseous perihepatitis and perisplenitis are almost constant findings. One finds also very frequently a tumor-like change of the great omentum, the latter being contracted longitudinally but at the same time enormously thickened and projected upward against the abdominal wall in such a way that it is often accessible to palpation intra-vitam and gives occasion the more readily to diagnostic errors because the objective clinical signs of tuberculosis may be entirely absent. The section of such omental tumors shows that they are completely made up of tuberculous granulation tissue in which large and small cheesy nodes are abundantly interspersed. On the peritoneum one finds also tuberculous nodes of luxurious growth like mushrooms. Often the tissue of the spleen is filled with caseous nodules. Of course the bronchial and mesenteric glands are also seriously affected, and on the other hand true pulmonary tissue and intestine are either entirely intact or freshly, that is, secondarily infected. All these cases have an unmistakable similarity to tuberculosis of cattle, though of course this resemblance is only external."

"Wieting observed the surprisingly great number of tuberculous diseases of the lymph-glands, especially of the cervical lymph-glands, so that he inquired whether the mouth and pharynx do not form the portals of entry for the tuberculous virus much more frequently than has hitherto been assumed. The following is a quotation from Wieting:"

'As a proof of the great frequency of infection from mouth or pharynx, I record the enormous number of cases of tuberculous diseases of the cervical glands. Of 3256 cases in the polyclinic, 335 were of tuberculous lymph adenitis, almost exclusively of the neck, that is, over 10 per cent. of all cases treated. Of the total cases of tuberculous diseases, numbering 1244, there were of tuberculous lymph-adenitis of the neck alone 346, that is, 31 per cent., and these only cases which came into treatment especially on account of the lymph-gland affection. Of all the other cases of surgical tuberculosis, especially bone tuberculosis, there were scarcely one in ten that did not have at the same time an affection of the cervical glands.'

"Of the bone and joint tuberculosis in Turkey, I will only mention that according to Wieting this form was present in not less than 54 per cent. of the cases of surgical tuberculosis, and in 11.5 per cent. of all surgical cases. These are numbers that are three to five fold greater than those which we are accustomed to see in Germany. In the controversies which have arisen as to the portals of entry of the tubercle bacilli, it has been often assumed that a finding of primary intestinal tuberculosis is equivalent with alimentary infection from cows' milk. Our pathologico-anatomical material shows that this is not true for Turkey. Of 66 autopsies in tuberculosis, in 39 cases, that is, over 43 per cent., the undoubtedly oldest tuberculous changes were present in the intestinal tract or in the ab-

dominal cavity. In spite of this interesting and surprising fact, my knowledge of the customs and modes of life of the Turkish people enables me to determine with certainty that their infections from foods derived from cattle, as milk, butter, cheese and meat, play no role of importance. We must, therefore, still hold fast to the idea that, in Turkey also, transmission of tuberculosis from man to man is of the first importance. He who knows Oriental conditions, the ignorance and carelessness of the people, the customs as to eating, etc., can hardly doubt that in Constantinople all the possibilities are present for an extensive dissemination of tuberculosis by direct contagion. If in Turkey tuberculosis is really transmitted from man to man, that fact must be made apparent in places where numerous persons live for a long time crowded closely together. This condition was fulfilled in the military schools, all of them boarding schools, in which the young scholars, coming mostly from the provinces, were crowded together in quite insufficient space, under the worst possible hygienic conditions, on account of the constant overcrowding, and were obliged to eat and sleep together. These schools were really true breeding places of tuberculosis, although the scholars were originally usually healthy persons.

"In the old army medical school, the scholars of which were largely young army surgeons who had passed their examinations and were sent to the hospital for a year's additional medical instruction, we saw about 10 per cent. infected with tuberculosis every year, and on further investigation it regularly became apparent that this 10 per cent. was only a remnant of the much greater number of victims who had been eliminated on account of the disease during the nine years' period of schooling. This loss could also be estimated as an average of 10 per cent., so that in general

there were at least 20 per cent. of cases of manifest tuberculous infection in every class. About 200 soldiers were assigned to the hospital as nurses and other employees. Of these, also about 10 per cent. were affected with tuberculosis. Repeated examinations, not only on entering the service but during service, and applying not only to tuberculosis but also to malaria, lues, etc., gave us the impression that all these soldiers who originated in the provinces and had come to Constantinople for the first time, had infected themselves there. There can be no doubt that there are regions and zones in the Osman Empire which are free of tuberculosis. Aside from the regions with little tuberculosis in Turkestan and from the shepherd population in many regions in Anatolia who are practically free of tuberculosis, I would mention the lands in the south with a hot climate like Arabia, Tunis, etc., the population of which away from the coast is absolutely free of tuberculosis, but it is precisely these cases and the negroes from Africa, Nubia and Sudan who fall ill in a frightful percentage with tuberculosis in Constantinople.

"I believe that the stereotyped picture of consumption is formed under the influence of a relative tuberculous immunity of the civilized peoples thoroughly infected with tuberculosis, but that the more virgin the soil, that is, the less the people have come in contact with tuberculosis and are infected with tuberculosis, the more frequently do such severe acute generalized forms of tuberculosis appear as are so frequent in Turkey."

CHAPTER VII

DIAGNOSIS, ESPECIALLY TUBERCULIN DIAGNOSIS

The pulmonary tuberculosis with which we are familiar as "consumption" is characterized by three features; emaciation, cough and chronicity. This form of tuberculosis is also the prevailing type in the tropical community in which tuberculosis has long been endemic. In view, however, of the probably comparatively incomplete tuberculization of the population, one must be prepared to encounter more acute tuberculous disease, cases which have completely lost their perhaps recently acquired and certainly imperfect immunization and also cases which have never acquired any immunity worthy of the name. In lands where tuberculosis is not as yet widely disseminated, the acuter forms of tuberculosis will be the rule rather than the exception.

The first question which has to be decided in the further diagnosis of the tuberculous case is: Are there or are there not evidences of previous contact with tuberculosis, in other words, of a certain degree of immunity, which foretells a probably chronic course in those cases that are seen in their incipiency? When the disease is of some standing, the presence of a superficially situated cavity of the upper lobes, with its well-marked physical signs, broncho-vesicular breathing, especially over the upper parts of the lung (which in the relatively afebrile, ambulant case usually indicates fibrous changes), a chronic cough with somewhat abundant mucopurulent sputum are all signs of a chronic form of tuberculosis usually of a relatively benign type. This is not equivalent to saying that the prog-

nosis is necessarily good. In the individual case the previously existing immunity may have been altogether lost and there is always the possibility that a generalized tuberculosis may develop, as it were, out of a clear sky, in cases in which the morbid process has seemed to have little activity. In general, however, in cases that show in any way a previous acquaintance with tuberculosis, the disease will pursue a chronic course and may offer some prospect of arrest and even of cure. In those difficult cases in which there is a question whether ill health is to be ascribed to a masked tuberculosis, physical signs of pulmonary involvement being obscure or absent, the probability that this is the correct explanation is greater the more completely tuberculized the community and the better the hygiene of the patient — persons living under bad hygienic conditions who have had little opportunity for immunization are more likely to develop acuter forms of tuberculosis, if they fall victims to the disease.

In acute pulmonary tuberculosis there may be neither emaciation nor cough. The lungs are relatively dry, the accompanying bronchitis is usually not a conspicuous feature. There may be no expectoration — the African negro with pneumonia or tuberculosis, according to Mouchet, does not expectorate. At the outset an extensive broncho-pneumonia or a lobar pneumonia may furnish the usual auscultatory signs of pneumonia, crepitant and subcrepitant rales. But this stage is of brief duration. After massive caseation has occurred, no rales are heard except possibly coarse and distant rales from the larger tubes. So it may come about that the lungs have undergone the most profound and extensive changes without furnishing to the physician the indications which he has been accustomed to find in chronic phthisis.

Topical diagnosis is correspondingly difficult and dependence must be placed more largely upon general signs and symptoms.

The acute generalized and acute pulmonary miliary tuberculosis of the civilized world is secondary to an old lesion in the adult and is not accompanied consequently by enlargement of the lymph-glands. On the other hand, tuberculosis of the lymph-glands is a conspicuous, if not predominating feature in primary tuberculosis and enormous and acute enlargement of cervical, more rarely also of axillary and femoral glands may indicate the nature of the affection. The same criterion may be of help in the diagnosis of tuberculous meningitis. The fulminating forms of tuberculosis require to be distinguished from acute infectious diseases such as typhoid fever.

The cutaneous tuberculin test is of value in diagnosis if the result is a positive reaction. It is, however, likely to be negative in the class of cases which most require elucidation. The reaction is also usually negative in the cachexia of advanced disease, including tuberculosis, and is often absent or weakened in acute infectious diseases. Sensitiveness to tuberculin is one of the evidences of the reaction of the organism. An organism not recently stimulated by tuberculous poison may not react to the dosage of tuberculin employed. On the other hand an organism overwhelmed by an acute tuberculosis is incapable of reacting. And it would appear that in disease of a more chronic and less severe type the von Pirquet reaction is often negative in the tropics. Thus, three of the adult Hottentots tested by Zieman[1] in Kamerun who reacted negatively had signs of apical catarrh, and in German East Africa Man-

[1] Centralblatt f. Bakt. Ite Abt. Originale. Vol. 70, p. 118.

teufel[1] found the cutaneous reaction negative "at the beginning" in eight hospital cases of established tuberculosis with sputum positive for tubercle bacilli. Much[2] discovered at Jerusalem that the fellaheen coming from the country did not react at all to tuberculin, and explained this fact by supposing that they had not come into contact with tuberculosis. But if the Arabs live for some time in the cities they acquire a certain not high capacity for reaction. Yet this reactivity points rather to an inactive than to an active tuberculosis, for it is a remarkable fact that cases of active tuberculosis among the Arabs, not cases with cachexia but comparatively slight cases of gland and bone tuberculosis, were found to have either no reaction at all or a slight and delayed reaction to the cutaneous tuberculin test. Experiments by means of the complement binding reaction with his partial antigens showed Much that these cases had a humoral, though apparently not a cellular immunity, all of the partial antigens being present in their blood. As for pulmonary tuberculosis of the Yemenites and Arabs, this, too, Much says, is of a different type from that of the European, cases which lead quickly to death in which almost nothing is to be found clinically, neither old foci nor glands nor physical signs over the affected lung. Even fever may be absent. As might be expected, these cases do not react to tuberculin. Much ascribes the lacking reactivity of those of the Arabs who have comparatively slight tuberculosis to a racial peculiarity. The analogy of these cases, with the negative African cases cited above, is, however, evident. There is some evidence that bone tuberculosis occupies a peculiar position so far as the skin-reaction to tuberculin is concerned. Thus Ramsey, examining

[1] Arch. f. Schiffs-u. Tropenhyg. Vol. 18, 1914, p. 711.
[2] Beitr. z. Klinik d. Tub. Sixth Supplementary Vol., p. 25.

crippled children, reports that 17 boys and 11 girls in whose cases the clinical diagnosis was bone tuberculosis, had a negative von Pirquet reaction to both human and bovine tuberculin, the tuberculin being used full strength.[1] The total number of each sex examined was 58. Combining the two sexes, we obtain a positive percentage of 75.86, a low rate for known tuberculous cases tested with undiluted tuberculin.

Ritter[2] examined two series of cases of tuberculous sanatorium patients for the cutaneous reaction, the one with concentrated, the other with 25 per cent. tuberculin. The results are shown in the subjoined table, to which is added the findings of Mirauer,[3] with the same tests in non-tuberculous patients in hospital and in cases suspected of tuberculosis, each group having been subjected to both tests at the same sitting. Inoculations were made by both investigators with dilutions higher than 25 per cent. From their work it appears that the percentage of positive reactions diminishes in proportion to the degree of dilution of the tuberculin.

That Mirauer should have obtained a lower percentage of positive results is probably to be explained rather by his mode of interpretation than by a difference in the degree of tuberculization of his material, for the percentages of Ritter agree much more closely than his with those usually found in healthy men, and the " suspects " have a slightly lower positive reaction than the patients frankly classed as non-tuberculous. The findings show the necessity of using undiluted tuberculin if it be desired to ascertain what the true degree of tuberculization of a given group is, that is

[1] Am. Jour. Dis. Child. Vol. 10, 1915, p. 201.
[2] Med. Krit, Blätter. Vol. 1, 1910, p. 161.
[3] Beitr. z. Klinik d. Tub. Vol. 18, p. 51.

TABLE No. 2

CUTANEOUS TUBERCULIN TEST

Comparative results between undiluted and 25 per cent. tuberculin

STAGE (Turban) (Ritter)	TUBERCULIN 100 PER CENT.			TUBERCULIN 25 PER CENT.		
	Number of Cases	Number positive	Per cent. positive	Number of Cases	Number positive	Per cent. positive
First	153	140	92.	121	88	73.
Second	169	163	96.	115	91	79.
Third	74	71	96.	82	64	78.
Totals	396	374	94.4	318	243	76.4
Non-tuberculous patients (Mirauer)	145	128	88.	145	115	79.
Tuberculous suspects (Mirauer)	53	46	87.	53	41	77.
Grand Totals	594	548	92.2	516	399	77.3

to say, to approximate to this as closely as the nature of the test will permit. In fact, now that the specificity of tuberculin reactions is admitted, the use of dilutions of tuberculin in the cutaneous test has been inspired by the hope that with such strengths it might be possible to exclude inactive cases of tuberculosis. In other words, dilution is expressly intended to prevent what is especially needed in epidemiological investigations — the determination of the true condition of the apparently healthy individual as respects tuberculous infection. The tabulation now under consideration is particularly valuable to impress the fact that failure to react to the cutaneous test is not by any means necessarily due to absence of tuberculous infection, nor to an exhaustion of the vitality of the patient. The average

second stage patient of Table 2 could hardly have been far advanced in tuberculosis, while at the same time there could not have been much doubt as to the diagnosis.

The same is true of the subcutaneous use of tuberculin. Of Bandelier's[1] 500 sanatorium patients 173, or 34.6 per cent., reacted to the initial dose of 1 mg., 156 or 31.2 per cent. to 5 mg., 98 or 19.6 per cent. to 10 mg., and 36 or 7.2 per cent. to the second injection of 10 mg., while 37 or 7.4 per cent. failed to react. Twelve of the 37 were given larger doses, four reacted to 20 mg. and six only to 50 mg. Whether all patients who react in so slight a degree are in need of sanatorium treatment is a question that might be raised by the critical. Very possibly, too, some of the insensitiveness was due to antecedent tuberculin treatment, although Ritter expressly states that he endeavored to exclude from his tests those who were known to have been treated with tuberculin. But the point to be especially emphasized is that the patients subjected to these tests must all have been exposed to tuberculous infection after admission to sanatorium or hospital, if not before their entrance. Negative reactions therefore can not rightly be interpreted as proof of absence of contact with the tubercle bacillus. Ritter reports that of eleven healthy persons who had been much in contact with tuberculous patients and who certainly must have received infections only four reacted to 25 per cent. tuberculin. Perhaps the most striking instance of the truth which it is desired to convey is to be found in the case of one of his patients. This was a young man who was hoarse from a laryngeal lesion which had not ulcerated. There was an incipient cavity in the right upper lobe with slight catarrh. The sputum contained

[1] Beitr. z. Klinik d. Tub. Vol. 2, p. 285.

tubercle bacilli. But there was no fever, the appetite and nutrition were excellent and the patient, a merchant, was active in his work. Tuberculin subcutaneously administered even up to 20 mg. elicited no reaction. As Ritter says, certainly the absence of reaction in this case did not mean a bad prognosis, was not due, in other words, to a failure of vitality. While it is generally believed that all children who are infected with tuberculosis will give a positive reaction to tuberculin, von Pirquet recognizes the fact that certain undoubtedly tuberculous children are negative to the skin reaction " from unknown causes ".[1] Indeed the higher percentages of positive reaction obtained by Hamburger and others with the depot and stich reaction prove that the skin test is not sufficiently delicate to detect all cases of tuberculous infection even in children. For example, Nothmann found that 47.1 per cent. of children reacted after one cutaneous inoculation, 65.7 per cent. after two inoculations, and 77 per cent. when the depot reaction was employed after two negative skin reactions.[2]

Examination by the cutaneous tuberculin test was made by Colonel E. H. Bruns, U. S. A., in Germany of 159 American soldiers between the ages of 18 and 30 years, with no family history of tuberculosis, for the most part men of athletic build.[3] The following table gives the result of the tests, the men being classified according to their place of residence before enlistment as city, town and country dwellers:

Unfortunately the regiment to which these men belonged being on the eve of return to this country, it was impracticable to test farther the negative percentage.

[1] Wien. Klin. Wochenschr. Sept. 19, 1907.
[2] Berl. Klin. Wochenschr. Vol. 47, 1910, p. 381.
[3] The Tuberculosis Situation in the American Expeditionary Forces. Unpublished Report to the Surgeon General, U. S. A.

TABLE No. 3

CUTANEOUS TUBERCULIN TEST ON 159 HEALTHY SOLDIERS

Class	Number	Positive to 1st test	Percentage positive to 1st test	Positive to 2nd test	Percentage positive to 1st or 2nd test.	Positive to 3rd test	Percentage positive to 1st, 2nd or 3rd tests.	Negative to 3 tests
City dwellers.....	40	28	70.	7	87.5	1	90.	4
Town dwellers....	53	40	75.	9	92.5	2	96.2	2
Country dwellers.	66	54	81.8	10	96.9	0	96.9	2
Totals.....	159	122	76.7	26	93.	3	94.9	8

A similar test was made at the U. S. Army General Hospital No. 21, Denver, Colorado.[1] One hundred soldiers between 21 and 30 years of age of the Medical Department detachment of the hospital were tested with the cutaneous inoculation of tuberculin. In the first test 71 were positive, 29 negative. The negative cases received a second inoculation after five days, 24 becoming positive and 5 remaining negative, giving a positive percentage for the two inoculations of 95 per cent. One of the five negative cases was discharged at this time, the remaining four were tested by subcutaneous injections of tuberculin. All were negative to 1 mg. old tuberculin. All likewise failed to react to 5 mg. To the injection of 10 mg. three reacted positively and one negatively. A fourth injection of 20 mg. was given to the one who remained negative. There was no rise of temperature after this injection but the reaction

[1] Lieut. R. K. Stacey, Med. Corps, U. S. A. Unpublished Report to the Surgeon General, U. S. A.

was considered positive on account of the depot reaction — redness and swelling at the point where the tuberculin had been injected. A comparison of radiographs of this man taken after the first and fourth injections showed an obscuration in the second radiograph of certain markings which had been clear in the first, from which it was inferred that a focal reaction had occurred. The four cases which were given the subcutaneous test were all country boys from Nebraska, Kansas, Oklahoma and New Mexico, respectively, with no family history of tuberculosis. Although the radiographs of all four showed what were regarded as evidences of old tuberculous lesions of the deep lung they would probably have been considered as uninfected with tuberculosis if the subcutaneous test had not been resorted to. Disregarding the single individual who fell out, we have a probable 100 per cent. of active reactions in 99 individuals. The tuberculin was used full strength in both of the above series. The high degree of reaction to tuberculin in our soldiers shown by the foregoing tests is noteworthy on account of the idea, based on insufficient evidence, which has been entertained by some that the men of our army are largely unimmunized by previous tuberculization and are therefore in danger of acquiring a primary tuberculosis. The results above quoted correspond closely with those of Freund,[1] who submitted 61 Austrian soldiers to the cutaneous test with undiluted tuberculin and obtained 58 positive reactions, or 95.1 per cent.[2]

We may conclude from the foregoing that healthy adults

[1] Wien. Med. Wochenschr. 1908, Nos. 22 and 23.

[2] F. Hamburger reports that Gyenes and Weissmann examined 470 soldiers, patients who were not suspected of active tuberculosis, by means of the "stich" reaction and obtained positive results in 98 per cent. of the cases. Wien. Med. Wochenschr. 1917, p. 529.

in our civilization react about as freely as the clinically tuberculous to the cutaneous test with undiluted tuberculin. In both classes the reactions are negative in about five per cent. of cases. If advanced cases are excluded, the individuals who are insensitive to the von Pirquet test will be found as a rule to react to larger dosage with tuberculin. Whether racial peculiarities influence tuberculin reactivity is a question that invites farther investigation. Tuberculin should always be used undiluted when the cutaneous test is employed in epidemiological investigations.

For the cutaneous test the skin should be cleansed with alcohol, not with iodine. Von Pirquet advises the use of a "borer," a dull instrument for abraiding the skin. If this is used, there is always some inflammatory reaction in the controls and the question as to a positive result is decided by comparative measurements of the papule of the control and of the tuberculinized abrasion. Von Pirquet demands that the papule should measure 5 mm. more than the control in order to be considered positive. An insufficient "bore" is shown by the absence of scab. A better form of abrasion is produced by scratching the skin, without drawing blood, but deeply enough so that minute red points appear in the course of the scratch. A scratch untreated is made as control. Koch's old tuberculin is generally used. Much distinguishes three degrees of the positive reaction, slight, normal and severe. The positive result is shown by an inflammatory infiltration expressed by redness and swelling. This appears in from four to six hours and reaches its maximum in from 24 to 48 hours. The lesion is more distinct upon thin than upon thick skin. The inner surface of the forearm is the best place for the scarification. Special types of the reaction have been described: the premature, the persisting and the late. The premature

reaction has a rapid course and slight intensity, reaching its maximum in ten or twelve hours and disappearing on the second day at the latest. It is supposed to occur in cases of manifest tuberculosis which are not improving. The other two types are found in cases with inactive lesions. The persisting reaction begins like the normal reaction but continues for a much longer time, while the late reaction is slow in making its appearance as well as in receding. The cases should be examined in 24 and 48 hours.

A more sensitive test than the cutaneous inoculation is found in what is known as the combined depot and "stich" (puncture) reaction. If the first cutaneous inoculation is negative, a second is given after three days. If the second inoculation is also negative, give a subcutaneous injection of 1 mg. If this injection is negative, according to Hamburger,[1] active tuberculosis may be excluded, the only exception being cases with very advanced or miliary tuberculosis in the last days before death, which would not, of course, be subjected to the test. A tuberculin reaction is not at all dangerous to inactive tuberculosis; one need have no fear of rendering such foci active by exciting the reaction. On the contrary, it is probable that such a reaction is of benefit in arousing the immunizing powers of the organism, and in such cases tuberculin injections even appear to stimulate the metabolism, sometimes producing increase of weight. The cases of inactive tuberculosis, in short, are the very cases that are most benefited by the use of tuberculin, although, of course, they need its help less than those with active disease. It is perfectly safe, therefore, to continue the test with larger doses. After waiting

[1] Die Tuberkulose des Kindesalters, 1912. The directions for preparing tuberculin are taken in great part from this work.

three days, repeat the dose of 1 mg.; if the result is still negative, follow successively at three-day intervals with doses of 5 mg. and 10 mg. If 10 mg. is negative, repeat the same dose, after which, if the result continues to be negative, the dose may be increased to 20 mg. The size of the injection should not exceed 1/10 c.c., nor should a stronger dilution than 1/10 be employed. If necessary in large dosage, more than one injection may be given. The syringe used should be graduated in tenths of a c.c. The necessary dilutions are prepared either with a pipette graduated in 1/10 c.c. or with a not graduated pipette, counting the drops. For diluting fluid use 0.8 per cent. sodium chloride solution, containing 0.5 per cent. carbolic acid. Put 9/10 c.c., or 9 drops, diluting solution into a watch-glass with a pipette. With a second pipette take tuberculin from the original bottle and add 1/10 c.c., or one drop, to the watch-glass. Mix well, and from this ten-fold dilution put 1/10 c.c. or one drop, into a second watch-glass with 9/10 c.c. or nine drops of diluting solution. Mix again, and from this 1/100 dilution put 1/10 c.c. or one drop into a third watch-glass with 9/10 c.c. or 9 drops of diluting solution. This gives solution 1/1000, etc.

To inject 1 mg. give 1/10 c.c. of the 1/100 dilution. For 5 mg. add an equal amount of diluting solution to a few c.c. or drops of the 1/10 dilution, making dilution 1/20. Of this dilution 1/10 c.c. equals 1/200 gm. or 5 mg. Of course, 10 mg. is contained in 1/10 c.c. of the 1/10 dilution.

The needle of the hypodermic syringe should be pushed well in, but its tip should lie directly beneath the skin. A positive reaction is shown locally by a reddened and tender swelling where the point of the needle has been (depot reaction), also by redness of the point of puncture of the skin, and, not as frequently, of the canal of the puncture

(stich-reaction). The redness and infiltration begin in 4 to 8 hours, generally reach a maximum in 24 hours and should last at least three days. The breadth of the swelling is about 10 mm. In the less sensitive cases the "stich" reaction may be absent, though the depot reaction is present. If the depot reaction is distinct, the result may be considered positive though there be no rise of temperature, provided that the size and strength of the doses already specified be not exceeded. There may however be some redness and swelling due to the irritant effect of the tuberculin when the 1/10 dilution is used for doses of 10 mg. or more. In case of doubt a control injection can be made by evaporating a four per cent. glycerine bouillon to one-tenth of its volume in a water-bath and using this diluted to the same strength and in the same dose as that of the tuberculin injection with which it is to be compared. The temperature should be taken after the injection at not more than three hours' intervals, at least during waking hours. Hamman and Wolman[1] regard an elevation of one degree Fahrenheit above the previous maximum temperature as sufficient to indicate a positive reaction, but no subcutaneous injection of tuberculin should be given until it has positively been ascertained that the temperature of the subject is perfectly normal. Care should be taken to follow up the cases injected subcutaneously, for if a febrile reaction to tuberculin is overlooked and increasing doses continue to be given at short intervals the result may be a temporary insensitiveness to tuberculin, even in the largest doses, a condition which would lead to misinterpretation of the nature of the case.

The above method is a safe one for the determination of

[1] Tuberculin in Diagnosis and Treatment, 1912.

tuberculin sensitiveness of healthy persons belonging to the fairly well immunized community. The sick who are suspected to have tuberculosis and known tuberculous cases should not be given tuberculin subcutaneously for diagnostic purposes. But if the cutaneous test shows a small percentage of positive cases so that immunization may be inferred to be absent or very imperfect, it would be more prudent not to employ tuberculin subcutaneously in the doses recommended above, the danger being the presence of a masked primary tuberculosis though the skin fail to react. Dependence would be placed solely upon the cutaneous test for the epidemiological investigation of such a group. If the determination of special cases should be regarded as important, give doses subcutaneously of from 0.0001 mg. to 0.1 mg. within 48 hours after the negative skin reaction and, in case repetition is necessary, following with the succeeding doses at 24 hours' intervals in order to avoid febrile reactions, the result being read from the stich reaction. This method has chiefly been employed in the diagnosis of the tuberculosis of young children, but there seems to be no reason why it should not be used in the case of unimmunized adults. An accurate physical examination should of course be the invariable preliminary to the diagnostic use of tuberculin by subcutaneous injection.

A radiograph of the lungs and examination with the fluoroscope in the oblique diameters of the thorax for glandular masses at the hilus and elsewhere in the central shadow may throw light upon some cases.

Under the inspiration of Calmette the cutaneous tuberculin test has been used in many of the French colonies as a means of ascertaining the degree of tuberculization of the communities, the strength of the tuberculin used under his instructions having been 25 per cent. It has also been

employed in some of the German possessions in Africa and in the Pacific. The data obtained are fragmentary and inadequate but convey some interesting and valuable facts in corroboration of the views that have been expressed.

At Réunion, of 846 children, one to fifteen years of age, 344 were positive for the skin test, or 40.6 per cent.; of 380 persons fifteen years or over 308 were positive or 81 per cent.[1] At Guadeloupe children one to fifteen years of age were positive in 38 per cent.; persons over fifteen years of age in 41.6 per cent.; at Martinique children one to fifteen years in 35.6 per cent.; persons over fifteen in 57 per cent.[2] The results in these old colonies may be compared with Calmette's findings at Lille, where of 366 children five to fifteen years of age 81.4 per cent. and of 236 over fifteen, 87.7 per cent. reacted. From Tonkin it is reported that of 884 persons over fifteen years of age, 369 were positive to the skin reaction or 43.7 per cent. At Hue, in Anam, of 699 persons thirty-one to seventy years of age who were tested, 429 were positive or 63.5 per cent.[3] Students of the colleges of the Mandarinate, teachers and high officials, 127 in number, gave 90 positive reactions or 70.8 per cent. Of 58 prisoners 41 were positive or 80.1 per cent. Such reactions to 25 per cent. tuberculin show a tuberculization, of the higher classes at least, in Anam which is practically equivalent to that of Europe.

Salecker reports of the Ladrones that investigations with the von Pirquet reaction show that different groups of the population of these islands react very differently.[4] Among

[1] Enquête sur l'Epidémiologie de la Tuberculose dans les Colonies Françaises. A. Calmette, Ann. de l'Institut Pasteur. Vol. 26, 1912, p. 497.
[2] Noc, Bull. de la Soc. Path. Exot. Vol. 6, 1913, p. 368.
[3] Bernard, Koun and Meslin, Bull. Soc. Path. Trop. 1912, p. 234.
[4] Arch. f. Schiffs-u. Tropenhyg. 1915, No. 4, Abstr. Deutsche Med. Wochenschr. 1915, p. 1080.

the chief people, the Chamorros, who have lived for centuries in close contact with the Spaniards and are largely half-breeds, tuberculosis in its extension and character corresponds to that of Europe. The Saipans, who emigrated from the Carolinas 80 years ago, a strong and vigorous tribe, had positive reactions in only about one-third of the cases, but in another group recently arrived from the Carolinas 70 per cent. were positive. Another group showed no positive reactions at all with the single exception of a girl who had worked in the house of a Chamorro. The course of tuberculosis was malignant only in the Carolinians, who also had the proportionally greater number of cases of manifest disease. These results show how impossible it is to determine the true status of a mixed population without extended investigations.

The town of St. Louis, in Senegambia, became a French colony in the 17th century. Its inhabitants have therefore long been in contact with Europeans. At the same time the natives inland have probably been little influenced. Apparently the population of the seacoast is reinforced by accessions from the interior for the rate is lower than would be expected. At St. Louis the test was made by Bourret and Bourragué[1] upon laborers of the military hospital, the pupils of public schools and the sick at the dispensary, groups especially likely to have been exposed to tuberculous infection. Of 1573 children, one to fifteen years of age, 280 were positive or 17.8 per cent., and of 957 persons over fifteen, 146 were positive, or 15.2 per cent. Here the children are infected in larger percentage than their elders from which it might be concluded either that there was some source of infection at the schools, or that among the

[1] Bull. Soc. Path. Exot. Vol. 6, 1913, p. 11.

adults examined there had been a recent accession of unprotected persons. At Leopoldville, in the Belgian Congo, the cutaneous reaction of the apparently healthy was examined, excluding hospital patients. Fourteen of 359 workmen of the shops at the port reacted positively; in twelve the reaction was slight or doubtful and 333 were negative. It is stated that those who gave a positive reaction did not appear to be in good health. Seventy-five agricultural laborers and 113 inhabitants of a distant native village gave one slight or doubtful reaction in each group. Mouchet[1] estimates the positively reacting percentage of the population at 7 per cent. and remarks that it reacts to tuberculin like the European infant. Correspondingly the nature of tuberculous lesions found by him at autopsy points to primary tuberculosis. Wagon[2] tested 100 adults in French Guinea with tuberculin and obtained twelve positive reactions. But one of the twelve was a prisoner with no history and the remaining eleven were all men not native to the country (dépaysés) and had occupations which had long kept them in contact with Europeans or Syrian merchants. The genuine natives therefore all reacted negatively in this series.

On the Ivory coast Sorel[3] found 12.4 per cent. positive reactions among 405 of the natives of a small town on the coast, and at Bassam he obtained 26 positive reactions or 20.9 per cent. in 128 adult natives who worked at the wharves, in the ship-yards, etc. But at Bonake, 350 kilometers from the coast, a place not yet reached by the railroad, Arlo, according to Sorel, obtained only two per cent. of positive results. Evidently here the amount of tubercu-

[1] Bull. Soc. Path. Exot. Vol. 6, 1913.
[2] Le Caducée. Vol. 10, 1910, p. 52.
[3] Bull. de la Soc. Path. Exot. Vol. 5, 1912, p. 855.

lous infection is directly as the closeness of contact with Europeans or other tuberculized individuals. Sorel however infers that the blacks are naturally highly resistant to tuberculosis but that their resistance is broken down by addiction to alcohol, which is naturally the more abundant the better the means of communication, a view which is unfortunate in that it tends to befog the main issue — the protection of the unimmunized natives against massive infections with tuberculous virus. In German East Africa, in the town of Kilwa, 58 negro school children gave a positive reaction in 22.4 per cent. and 17.4 per cent. of 98 negroes (mostly "boys" in Hindoo retail shops) and 25.4 per cent. of 79 Hindoos were positive. Peiper[1] believes that the Hindoos are the bearers of contagion to the blacks. The coast cities where the Hindoos come first and stay longest are most infected. At Daressalem, Manteufel[2] found 25.6 per cent. of native children and 30.9 per cent. of Hindoo children to give a positive reaction, while the adult natives and the adult Hindoos had a positive reaction in only 22.4 and 22.3 per cent. respectively. At Tanga, Müller tested 600 patients of the native hospital without selection.[3] Of these, although there were only three clinically demonstrable cases of tuberculosis, 200 were positive to the skin test, showing, he says, a greater degree of tuberculization than has hitherto been assumed.

From Kamerun, Zieman[4] reports that of the Bantu soldiers, men from various tribes, 91 men were examined of whom 4 or 4.4 per cent. were positive. Of 82 women three and of 62 children two were positive. But 80 negroes, men,

[1] Arch. f. Schiffs-u. Tropenhyg. Vol. 16, 1912, p. 431. Also: Idem. Vol. 15, 1911, Beiheft 2,
[2] Idem. Vol. 18, 1914, p. 711.
[3] Arch. f. Schiffs-u. Tropenhyg. Vol. 18, 1914, p. 690.
[4] Centralbl. f. Bakt. 1te. Abtlg. Originale. Vol. 70, p. 118.

women and children, from the highlands were all negative except one man, who had lived on the coast as a soldier. On the other hand, in a wretched group of exiled Hottentots, of 34 adults, 22 gave a positive reaction and of these 15 had signs of apical catarrh. Three of the twelve adults with negative reaction had the same physical signs.

In Kaiser Wilhelmsland (New Guinea or Papua) Kersten[1] tested 22 children and 39 women on the Waria River and 42 children and 17 women on the Morobe River, all of whom were negative, but found that of 74 men of the Waria group 17 were positive (23 per cent.), and of 56 men of the Morobe group 15 or 26.8 per cent. gave a positive reaction, explaining the preponderance of infection among the men by the fact that they had been hired from time to time as laborers since 1903. The Namalas are only in superficial contact with the whites, although men of the tribe have worked on plantations since the early nineties. Of these 44 adult males were all negative, but of 44 natives at the station 12 or 27.3 per cent. were positive. In the Bogadjin villages near Friedrich Wilhelmshafen 36 children 6 years of age or less were all negative and of 50 older children not more than 14 years of age, four were positive while of 76 adult women 15 or 19.7 per cent. were positive, and in 85 men there were 23 positive reactions (27.1 per cent.). These men had been constantly in contact with whites, Malays and Chinese since the beginning of the settlement. In New Pomerania (an island near Papua, also known as New Britain) in a region remote and rarely visited by Europeans, Kopp[2] found that of 170 men, 39 or 22.9 per cent., and of 118 women 7 or 5.9 per cent., were

[1] Arch. f. Schiffs u. Tropenhyg. Vol. 19, 1915, p. 101.
[2] Idem. Vol. 17, 1913, p. 729.

positive, while only two of 113 children or 1.8 per cent. reacted positively.

On the east coast of Sumatra the large "plantation companies" employ about 20,000 laborers in the cultivation of rubber trees. Of these, about nineteen-twentieths are Javanese, the remaining being Chinese and coolies from Further India. Heinemann[1] states that in 284 cases dead from other causes, only four showed an old apical tuberculous focus. Of 69 deaths which he reports in detail, he found that 59 were due to tuberculosis. Cheesy lymph-gland tuberculosis was the most prominent affection in many of the fatal cases. Those in which pulmonary tuberculosis was present had usually the cheesy broncho-pneumonic or lobar pneumonic type. The proliferative form of pulmonary tuberculosis with manifestations of a reparative tendency was rare. Bone tuberculosis was found but once, tuberculides of the skin and lymphoma of the neck never. The course of the tuberculosis was generally rapidly fatal. Evidently we have here primary tuberculosis with only a small admixture of cases in which there was any evidence of immunity from previous infection with tuberculosis. Formerly the Javanese laborers were very carefully selected for the Sumatra plantations in the rural districts of Java. The immediate isolation of all manifest tuberculosis and the removal of newly immigrating coolies with open tuberculosis sufficed to keep down the curve of tuberculosis morbidity. But with the extension of rubber culture over the whole east coast of Sumatra the demand for laborers became so great that they were recruited from all parts of Java, especially the cities, and the former strictness of selection was relaxed on account of the pressing need of men. With the importation of 7000 additional coolies in

[1] Hamburgische Med. Ueberseehefte. Vol. 1, 1914, p. 34.

1911, 1912 and 1913 the rates of admission to hospital for tuberculosis increased from 0.2 to almost 0.6 per cent. Using the cutaneous tuberculin test, Heinemann found 125 men positive out of 3580 or 3.5 per cent.

It is generally assumed that the members of an unprotected race who give a positive tuberculin reaction are about to fall ill with primary tuberculosis. This did not seem to be the case in this instance for Heinemann remarks that so far none of those with a positive von Pirquet reaction have developed manifest tuberculosis and thinks it possible that they had received their infection in some of the cities of Java from contact with Europeans, Chinese or Arabs, so that the conditions of infectiousness had been similar to those of Europe (i. e., there was an opportunity to develop an immunity from a small infection). Now the most interesting fact is this: Heinemann states that in the increase of morbidity from tuberculosis it was not the newly arrived that fell sick but that the greater part of the patients were the older men who had worked on the estates for years. Only twice could it be discovered that the sick had been in the vicinity of cases of manifest tuberculosis, but they are known to have been near men with a positive reaction for tuberculin. Accordingly Heinemann thinks that the apparently healthy bacillus-carriers, as occasionally "bacillus-excreters," were to blame for most of the infections. These investigations constitute a valuable contribution to the endemiology of tropical tuberculosis.

While the tropics furnishes the most fruitful field for such observations the same laws are seen to be in operation wherever an uninfected population is brought into contact with the outside world. Parrot[1] found at Duzerville, in Algeria, that the rural natives gave 21.2 per cent. of posi-

[1] Bull. de la Soc. Path. Exot. Vol. 5, 1912, p. 902.

tive reactions to the cutaneous test, the native villagers 42.8 per cent., and remarks that it is the natives who live most in contact with Europeans who are the most infected. This fact is shown on a more extensive scale by the observations of Metchnikoff and his colleagues among the Kalmucks.[1] From the medical statistics of the Astrakhan government it appears that pulmonary tuberculosis is found throughout the steppes but is less frequent in the central portions remote from the Russians. Metchnikoff found the same to be true of tuberculosis of the bones and joints. This party examined 3264 persons, of whom 2949 were Kalmucks, by the cutaneous test with 50 per cent. tuberculin. In the periphery of the region 89.5 per cent. of the men and 75 per cent. of the women gave a positive reaction. In the central portions only 43 per cent. of the women were positive. The men who had 64 per cent. of positive reactions were more highly infected than the women because they came more frequently into contact with the outside world. The population of the outer regions called "sedentary" in contrast with the nomadic Kalmucks give figures comparable with those of Europe. Of 38 Russians and adult Mussulmen examined at the Bazar des Kalmouks only one young girl of sixteen was negative. According to Metchnikoff, Khlopine, writing in 1911, stated that the adolescent Kalmucks pursuing the course of the secondary schools in Astrakhan do not finish their instruction. When they reach the fifth or sixth year they begin to grow feeble, become anaemic and finally develop tuberculosis. This was so generally true that the school for Kalmuck girls was given up and there was even question of transporting the secondary school for boys from Astrakhan to the steppes.

[1] Metchnikoff, Burnet and Tarassewitch, Ann. de l'Institut Pasteur. Vol. 25, 1911, p. 785.

At the Kalmuck boarding school in Astrakhan 715 pupils attended the course, in the 45 years from 1865 to 1910. Of this number 75 died before finishing their studies, 27 were obliged to leave Astrakhan on account of tuberculosis, and the remaining 613 shortened their course in order to return home. During the later years the mortality has diminished, no doubt because of progress in tuberculization. Thus, according to Khlopine, the mortality which was formerly 118 per 1000, fell in the decade 1895-1905 to 31.7 per 1000. It is noted that certain students, physicians, jurists and orientalists, have even finished their course of instruction, something never seen formerly.

When the scholars returned to Astrakhan from the steppes in October, they were all tested by Metchnikoff by the von Pirquet method. Of a total of 53 pupils 16 had arrived to commence their studies, aged eleven to fifteen years and in good health. Of these eight gave a feebly positive reaction. Of three pupils who had lived more than one year at Astrakhan only one was negative.

In semi-civilized countries long in touch with civilization the percentage of positive skin reactions approaches that of European communities, but is not apparently, as a rule, so high. It seems to be higher in the better-educated classes than in the poorer and more ignorant inhabitants, from which fact — the opposite to that which obtains in Europe — it may be inferred that the conditions of semi-civilized existence do not make for as thorough a tuberculization of the proletariat as is found in the large cities of a higher civilization. Correspondingly it would appear that the type of tuberculosis present is often rather more acute than that with which we are familiar.

In the countries more recently infected with tuberculosis, the percentage of positive skin tests is directly as the close-

ness of contact with Europeans, Hindoos, Chinese or other tuberculized individuals. There is an exact parallelism between the cutaneous reaction and the clinical course of tuberculosis, so that one can be predicted if the other is known. Where chronic pulmonary tuberculosis is the prevailing type, the percentage of positive skin tests will be high, where the positive percentage is low, tuberculosis will be rarer but severe and acute.

It is especially important to note that even Africans and the inhabitants of the islands of the Pacific are capable of developing an immunity, that is, they become tuberculin-sensitive but do not immediately develop tuberculous disease. How efficient an immunity that begins its development in adult life will be in preventing manifest tuberculosis or in modifying the type of the disease remains for further study to ascertain. A thorough and detailed study of the incidence of tuberculous infection upon the natives of the tropics by means of the cutaneous reaction to tuberculin will throw much needed light upon this subject.

If, as would appear from the facts cited in previous chapters, the members of a civilized community are protected to a large extent against acutely fatal tuberculosis although the disease is always so widely prevalent that opportunities for infection must be frequent, it would logically follow from analogy with other infectious diseases that their immunity depends upon their having had tuberculosis. This view demands the assumption of so widespread a tuberculization of our race that it has naturally encountered much opposition. Tuberculin tests have rendered inestimable service by proving that such tuberculization does indeed exist. The fact that nearly one hundred per cent. of civilized adults give, sooner or later, a positive reaction to tuberculin agrees with and supports the findings of pathologists

CHAPTER VIII

PROPHYLAXIS OF THE NON-IMMUNIZED

In making a survey of the situation of the tropical community as respects the tuberculosis problem, the health officer has first to satisfy himself as to the degree of tuberculization which exists in general in the population. To this end he would naturally seek answers to the following questions: What is the prevalent type of tuberculosis? Is it pulmonary tuberculosis? Are cases of pulmonary tuberculosis usually of a rapid or of a slow course? In other words, are there many individuals that have had the disease for years with progressive emaciation and considerable cough and expectoration or do the cases, as a rule, end in a few months? Do patients ever live long or recover after attacks of pulmonary hemorrhage? What is known as to bone and joint tuberculosis? Are there humpbacks, cases of hip-joint disease? Have many of the children playing in the streets swollen glands of the neck? When tuberculosis enters a family as a manifest disease, is the entire family swept away or, on the other hand, is the course slow in members secondarily affected or again do some escape entirely?

When tuberculosis seems to end rapidly in death (allowance should be made here for the probability that many cases will not be recognized until the last stage of the disease) do the patients often or ever have massive swelling of cervical, femoral and axillary glands? After what has already been said, the significance of the above questions will be sufficiently apparent.

Though the von Pirquet reaction as an aid in the diagno-

sis of the individual case leaves much to be desired, it is nevertheless an invaluable method for obtaining expeditiously, cheaply and safely the facts in a general way as to the dissemination of tuberculosis in a community or group of individuals.

The degree of tuberculization is, of course, shown roughly by the percentage of individuals positive for the skin test. What is to be thought of the negatively reacting depends upon this percentage and also the history of the case. Thus a native of Manila, who pretty certainly has come into contact with tuberculosis, if he reacts negatively, probably does so because the dose of tuberculin has not been large enough to awake his reaction, whereas in the case of a man recently arrived from a remote rural district, a negative reaction may well mean the absence of an immunization. It is not likely that any community will be found to-day to consist entirely of unimmunized individuals nor, on the other hand, are there probably many communities in the tropics which have reached as high a degree of tuberculization as that of the large industrial communities of northern countries. One class in all communities, the children, are exposed to the dangers of primary tuberculosis. But little has been done (much less than might have been accomplished if there had been an intelligent appreciation of the epidemiology of tuberculosis) for their protection in the most highly civilized portions of the globe. The desiderata, of course, are cleanliness, good hygiene in general and, above all, if in any way possible, the separation of the child from known sources of infection; in other words, remove the baby from the consumptive or the consumptive from his or her family. One can at least teach a few elementary truths, for example, do not chew the food for your children, do not cover the heads of the family at

night with a blanket or mat, do not let people live with you who have coughs. Do not let anyone spit on the floor.

In the non-immunized community the influence of the bacillus-carrier has already been dwelt upon. Peddlers seem to carry infection with their wares. According to Calmette[1] in southwestern Africa the Haoussas (Musselman peddlers) had a higher percentage of positive cutaneous reactions than the natives, which was also true of the Syrians. Both of these classes are believed to spread tuberculous infection. Among the uncivilized such itinerant vendors are a much greater menace than they would be with us even though we were equally defenseless against tuberculosis, for they not only may carry infected wares but they also eat with the family and sleep with the family, and no doubt expectorate upon the floor with the same freedom as the family. In the unprotected community regulations might well be adopted to require this class of persons to lodge and to eat by themselves.

A great responsibility rests upon the physician in the case that groups of uninfected individuals are introduced into infected surroundings as when gangs of laborers are brought from remote rural districts to work in towns or in garrisons. Such men should be at once examined by the cutaneous test, cases of manifest tuberculosis, if such are found, being of course at once isolated and the negatively reacting should be quartered separately. The positively reacting, in the absence of signs of manifest tuberculosis, could be safely quartered with laborers of more thoroughly tuberculized races, as the Chinese and Japanese. These considerations do not, however, apply with as much force if the group in question reacts in a large percentage to

[1] Tuberculosis. Vol. 13. 1914, p. 355.

tuberculin, which would, of course, show that it is pretty well infected.

The quartering of natives in large barracks, if these are hygienically good, seems at first sight a step in advance in sanitation, ventilation and "police" being easily kept much better than in crowded native huts. Experience has shown, however, that so far as relates to the communication of infection this is not the case. In the Panama Canal Zone the death rate among negro laborers from pneumonia in 1906 was 18.74, in 1907 10.61, but in 1908 it was only 2.60 per 1000. General Gorgas[1] ascribes this marked improvement to the fact that the practice of quartering the negroes in large barracks was given up at this time. The men, for the greater part, were permitted to live in huts with their families and to prepare their own food. No doubt the result was worse ventilation and worse food but the diminished liability to infection more than counterbalanced these disadvantages. Where communicable diseases prevail, the spread of infection is best prevented by quartering the susceptible in small units. In unprotected races these considerations apply as closely to tuberculosis as to pneumonia. The fact that they are universally disregarded with us without harm appearing to result therefrom is an excellent proof of the extensive tuberculization of our race. The recent experience in our army of the effect of the introduction of the cubicle system in preventing the spread of streptococcus infection, pneumonia, meningitis, etc., is familiar to all. If we were as sensitive to the tubercle bacillus as we are to the streptococcus, acute tuberculosis would long ago have decimated our army.

It is to be expected that the unprotected native will come

[1] Jour. Am. Med. Assn. Vol. 62, 1914, p. 1855.

into contact with the tubercle bacillus. It is the duty of the physician to minimize the opportunities for massive infection. Isolation of healthy laborers in the strict sense of the word is, of course, impracticable. In fact, working in the fields with the already tuberculized, where contact would rarely be intimate and where ejected tubercle bacilli are likely soon to become harmless by exposure to the sun, does not necessarily result in infection. This is almost inevitable, however, if the unprotected eat and sleep with bacillus-carriers. It is, of course, of extreme importance that cases of "open" tuberculosis shall be isolated as soon as detected. They should not be treated in hospital wards occupied by uninfected natives sick with other diseases. The usual precautions as to disinfection and the destruction of tuberculous sputum should be carried out with extreme care. They are much more necessary than in a race as thoroughly tuberculized as is our own.

On account of the almost universal immunization of our race from early tuberculous infection, our sense of tuberculosis as a communicable disease has become blunted. But tuberculosis, as Hamburger says, is really as infectious as measles. And nowhere better than in the tropics do we see how terrible a disease it is when it comes as a massive infection upon the entirely unprotected individual. Bearing these facts in mind, we must necessarily change our views as to the danger of introducing the consumptive into the community. That which seems and is a venial offense if the community is immunized on the whole against tuberculosis becomes a grave danger if there is present a considerable number of unimmunized or very imperfectly immunized individuals.

In Bengal, according to the Rev. Dr. Kennedy,[1] Chota

[1] Proc. Royal Soc. of Med. Vol. 7, Pt. 2, 1913-14, p. 195.

Nagpur had so little tuberculosis that sanatoria were built there and consumptives came in and lodged everywhere in the town, with the result that there was a great increase of tuberculosis among the natives. South Africa has had a similar experience on a larger scale. Macvicar[1] remarks that though Europeans suffering from phthisis who come to South Africa for their health have a better chance of recovery in the high and dry districts than upon the coast, the condition of native life favor the spread of tuberculosis and the fact seems to be that it does spread rapidly wherever it has been introduced. At Burghersdorp, altitude 4550 feet, the death-rate for consumption among the native population is 9.5 per 1000. At Beaufort West, altitude 2792 feet, and with a small rainfall, the native death-rate is 18.5 per 1000. Both of these towns have been and still are regarded as being possessed of climatic advantages especially suited to the cure of consumption and invalids from Europe go there to live. The report of the Medical Officer of Health of Cape Colony for 1905 says: "It is a significant fact that centres such as Beaufort West, which we formerly knew to be free from the disease and which, owing to their peculiarly favorable climatic conditions, have been chosen as health resorts by immigrant consumptives, should at the present day be the most severely afflicted by the disease. Consumption has now secured so firm a foothold among the native and colored (i. e., mulatto) population in Cape Colony that it is spreading in most of the towns and even in towns in which it is diminishing among the Europeans."

In Cape Colony, a region long civilized, it would not be expected that the native population should have entirely escaped infection with tuberculosis until recent years. It

[1] South African Med. Rec. Vol. 4, p. 133.

is an example, therefore, of a land in which the native population is imperfectly immunized rather than entirely unprotected against the disease. Accordingly we find that hygienic conditions, which would make little difference if a virgin population were exposed for the first time to a massive tuberculous infection, have a very noticeable effect upon the native death-rate from tuberculosis. The Health Officer of Cape Colony goes on to say: "Port Elizabeth and East London would seem equally situated as regards climate except that Port Elizabeth has a rainfall of 21 inches while East London (both are seacoast towns) has 35 inches. Yet in Port Elizabeth the tuberculosis death-rate is 15.1 per 1000, that of East London 3.4 per 1000. King Williamstown, with an altitude of 1275 feet, has almost the lowest native death-rate, 2.5, while Grahamstown, not far distant, with an altitude of 1741 feet, has a native tuberculosis death-rate of 8.3 per 1000. The conclusion from these facts is that while height above the sea and dryness of climate are beneficial to patients under favorable conditions, in the colored and native population as a whole their influence does not appreciably retard the spread of phthisis." But the editor of the South African Medical Record adds: "In these places which show a comparatively small increase in the native mortality from tuberculosis, the general sanitation has been much improved of late years but not in those with a heavy increase."

In a paper published in 1907, Kuhn,[1] inquiring whether South Africa is suitable for the treatment of lung diseases, referred to the experience at Davos, where no extension of tuberculosis from the guests and immigrating consumptives took place, and expressed the opinion that what applies to Davos with equal hygienic care would apply to

[1] Berl. Klin. Wochenschr. No. 6, 1907.

South Africa, where the hot sun is the greatest enemy of bacilli throughout the year. Kuhn refers to Sobotta, who, in a paper published in the same year,[1] gave expression to a similar opinion, namely, that the healthy population of South Africa is not threatened by the settling of pulmonary invalids. The slight density of population, the sun and the dry air diminish the danger of infection and the climatic advantages are more useful to the healthy than to the tuberculous patient. At Görbersdorf and Falkenstein, Sobotta says, it may be shown that the native population suffered less from tuberculosis after the erection of sanatoria than before.[2]

But new tidings from Cape Colony compelled Kuhn to change his views. He reports in another paper published in 1908[3] a disquieting extension of tuberculosis in the native population. There was no doubt, according to the statement of a physician, that the disease had been brought in by the numerous consumptives who have visited the Karoo. It has extended with marvelous rapidity in consequence of the carelessness of the patients, the ignorance of the nurses and the absence of precautions. Kuhn gives a table showing the death-rate from tuberculosis in the European and colored population of eleven towns. The rate of the colored varies from 6.36 to 14.37 per 1000, while that of the whites does not exceed 2.50 in any town except in four towns, three of which are stated to be the chief resorts of consumptives, who are largely responsible for the increased mortality. The highest rate, 6.34, at Beaufort West, is less than the lowest colored death-rate; the next highest is 3.6 per 1000.

[1] Berl. Klin. Wochenschr. No. 16.

[2] The sanatoria of Brehmer and Dettweiler were at Görbersdorf and Falkenstein respectively.

[3] Klin. Jahrbuch Vol. 20, 1908–09, p. 513.

Such an experiment on the grand scale in the epidemiology of tuberculosis as the introduction of a large number of consumptives upon a hitherto but slightly infected continent is one that can not be studied with too great care.

The bright sun and the dry air help the consumptive to regain his partially lost immunity, but the poison that he brings with him, once introduced among the almost unprotected native population, spreads from one to another by personal contact and carries them off with frightful rapidity, though they enjoy the same climatic advantages.

Sanitation is an excellent thing — its benefits are apparent in the situation that we are discussing — but much harm has been done by giving credit to sanitation that is really due to a previous immunization. "Hygienic care," which, Kuhn intimates, explains why tuberculous infection was not brought to the inhabitants of Davos by the visiting consumptives, cannot prevent the "droplet" infection in the vicinity of the tuberculous nor the possibility of the transmission of his disease by means of any article that he has touched. A sanatorium, though it were the best conducted sanatorium in the world, is a place of the greatest danger to the unimmunized individual. That the effect of sanitation in preventing infection is overrated is shown by the experience at another health resort where for many years consumptives lived in closest contact with the inhabitants of the town without any pretence of "hygienic care."

The great importance of clear ideas upon this subject justifies reproducing a portion of Werner's forcible exposition of the tuberculosis situation at Lippspringe[1] and Schlangen:[2]

"The population (permanent) of Lippspringe in 1830

[1] Beitr. z. Klinik der Tub. Vol. 19, p. 352.
[2] Idem. Vol. 24, p. 125.

was 1440, in 1909, 3472. The *absolute* tuberculosis mortality has diminished from a yearly average of 14.9 in the decade 1831-1840, the decade of the opening of the bath, to 12.25 yearly average in the four years 1906-1909. The percentage of tuberculosis to total mortality fell from 31.2 per cent. to 23 per cent. The relation of tuberculosis mortality to 1000 inhabitants fell from a yearly average of 9.8 in the decade 1831-1840 to 3.5 in the four years 1906-1909. It may be affirmed that for the decision of the question as to danger of infection from tuberculosis, especially pulmonary tuberculosis, at no time and nowhere in the world has a natural experiment of such extent and duration been made as in Lippspringe. For the period of observation extends from 1833, the year of the founding of the bath, to 1909, or 76 years. In these 76 years Lippspringe has been visited by 170,000 patients in round numbers. Of these certainly 80 per cent. or 136,000 were patients with pulmonary tuberculosis, of whom at least one-third or 45,000 were so-called open cases with tubercle bacilli in the sputum. The number 1000 (of patients) was reached in 1867, 2000 in 1874, 3000 in 1897. In 1896 the first state or insurance sanatoria appeared. From that time the number of patients rose rapidly. In 1906 there were more than 6000. From 1906 to 1909 the average number was about 8000. This yearly accumulation of pulmonary tuberculosis does not occur during the entire year, but, especially in earlier times, in the season — April to October — and not over a wide territory, but in a small place for the most part rather closely built up. Taking into consideration the number of open cases we may affirm that nowhere in the world has there been such a dissemination of bacilli as in Lippspringe since the establishment of the bath. It is to be considered that until the discovery of the tubercle bacillus by far the

greater number of doctors were not convinced of the infectiousness of tuberculosis, and especially in Lippspringe, as the records show, the old doctrine of crasis prevailed. No one then had the slightest idea of any control of expectoration. On the contrary, the more frequently the patient expectorated the better it was, for by the sputum the dyscrasia was removed from the body. Even after the discovery of the tubercle bacillus the view of the infectiousness of pulmonary tuberculosis spread very slowly among the public, the population of Lippspringe and the doctors there. We may then affirm that only with the appearance of the insurance patients in good numbers in 1899 was any great attention paid to controlling expectoration.

"Another important fact which concerns the population of Lippspringe is the following: The peculiar development of the bath did not lead at first to the building of large hotels and sanatoria in which the guests were more or less isolated from the population, but the latter, by the renting of rooms, by nursing and by taking boarders, was from the beginning in very close contact with the patients. The keeping of boarding houses increased greatly, especially after the patients of public sanatoria came in large numbers, so that it may be affirmed that since 1899 every second house shelters and cares for patients. From this it follows that half of the population during the summer are in constant contact with patients. This is more true of boarding houses than of public sanatoria, for the patients in the former are much more intimately brought in contact with their landlords than are patients of other classes. Moreover but few domestics were hired. In general the family itself attended to the housework, especially the cleaning of rooms.

"A further important fact for the interpretation of this

natural experiment is that the population of Lippspringe is very stable. Emigration practically never takes place. Therefore every case of infection must have become known.

"We have then a crowding together of numerous cases of pulmonary tuberculosis in a relatively small place and in a small community with enormous production and dissemination of tubercle bacilli for 76 years, the absence of all protective measures until about 1900, or 67 years, on account of the close contact a very considerable exposure of the population, together with originally unfavorable hygienic conditions, a great stability of the population and a diminution of the relative tuberculosis mortality to about one-third of its highest rate! From this it follows with certainty that the view of the contagionists as to the high infectiousness of pulmonary tuberculosis is totally false. If it were not, the whole population of Lippspringe, under the conditions described, must have been infected and must have died out.

Schlangen is 3 kilometers from Lippspringe. There are few tuberculosis patients in Schlangen, and until recently there has been no means of direct communication between this village and Lippspringe. Many girls go from these villages to take positions as servants during the season at Lippspringe. Infection if acquired would be brought by them to Schlangen, where for the most part they remain and marry. Cornet says: "Most endangered are the servant girls who make beds and sweep rooms."

"The general mortality in Schlangen has fallen from 28 per 1000 in 1834-1850 to 22 per 1000 in 1896-1908, and the tuberculosis mortality from 11 per 1000 in 1834-1850 to 6 per 1000 in 1896-1908. Especial importance is given to the fall in the general mortality, for if tuberculosis is increased the general mortality will be increased, and this will be true

whatever objections may be raised as to the correctness of the diagnosis as to tuberculosis. On the other hand, if the general mortality falls there can be no question of a widespread tuberculous infection of the community from the introduction from without of cases of tuberculosis. The total mortality is high, which manifestly points to unfavorable hygienic conditions, and the mortality from tuberculosis in Schlangen was high at the outset and in spite of its diminution is still high (for the same reason).

"A transmission of pulmonary tuberculosis at least to adults through transient association with cases of that disease does not exist and never has existed."

It is evident that hygienic care will not account for the difference in the effect produced by introducing the consumptive into Lippspringe and into Cape Colony. The tuberculous invalid is apparently harmless to the adults in places where tuberculosis is a common disease. He is a dangerous source of infection in a place where tuberculosis has been recently imported, though that place be a health resort which has approved itself for the cure of consumption. Is there any possible explanation of these facts except the theory that exposure to tuberculosis may result in a vaccination against the disease? And is it not evident that if resistance were not raised by contact with the tubercle bacillus the races now so highly tuberculized would have become extinct?

Calmette says: "The extreme diffusion of tuberculosis throughout the world and the facility with which it is propagated not only by the sick but also by the immense number of apparently healthy individuals who are carriers, lead us to consider as impossible — perhaps not even desirable — the total eradication of tuberculous infection".[1]

[1] Loc. cit.

Viewed in this light the practical prophylaxis of tuberculosis ceases to be prophylaxis of tuberculous infection and becomes prophylaxis of tuberculous disease. The task of the sanitation becomes a plain though not an easy one. It is first to diminish in every way the opportunities for massive infection so that as far as may be the initial dose of tubercle bacilli shall be small; secondly, to improve in every way possible the health of the community, to the end that the immunity gained by a fortunate initial infection shall not be impaired, that vaccination shall not be converted into manifest and dangerous tuberculous disease.

CHAPTER IX

TREATMENT OF TUBERCULOSIS IN THE TROPICS

Climate *per se* has little responsibility for the incidence of manifest tuberculosis except as it may favor complicating diseases which have an unfavorable effect upon the general health. As Hirsch says, the mean level of the temperature has no significance for the frequency or rarity of phthisis. The bad reputation of the tropics as respects tuberculosis is largely due, first, to the fact that climatic conditions are blamed for the rapid extension and fatal course of tuberculosis of acute types among a more or less completely unprotected native population; second, to the bad hygiene of a poor and ignorant people which facilitates the conversion of a potentially immunizing tuberculous infection into tuberculous disease and renders the course of the disease more acute.

By a tropical climate is generally understood the hot and moist climate of the tropical sea-coast, but there are to be found in the tropics climates which are hot and dry and those which are relatively cool and dry.

As we have already seen, in the tuberculized tropical sea-coast city pulmonary tuberculosis may pursue a very chronic course, the treatment of uncinariasis may almost transform a grave situation and hygienic betterments, such as an improved water supply, drainage and paving, may result in an appreciable diminution in the mortality from tuberculosis which in such a community rises and falls with the general mortality. In short, the situation as respects tuberculosis in such a city, though the mortality rate may be high, does not differ very essentially from that in north-

ern cities, and the remedies, improved sanitation and better education, are the same as have effected so great a diminution in the mortality from tuberculosis in more highly civilized communities.

These considerations are of importance in that they encourage endeavor. One of the best allies of the tubercle bacillus is the pessimist, who shrugs his shoulders and says that the conditions are hopelessly bad. It is uphill work of course, especially at the outset, but one may enter upon the treatment of tuberculosis in suitable cases among the native population with a reasonable hope of attaining arrest or even cure of the disease in a fair percentage of cases.

Some tropical communities are attacking the tuberculosis problem. Manila is the tropical city best known to the medical officers of the U. S. Army, and may serve as an example. It appears from the annual report of the Bureau of Health of the Philippine Islands for 1909-10 that an average of 1500 cases of tuberculosis per month are treated in the tuberculosis dispensary and that a night camp has been provided where 30 cases are under continuous treatment, and 100 additional cases sleep at night and receive instruction. At Baguio, two small pavilions having been constructed for tuberculous cases, the demand for accommodations became so great that three others have been built. It is stated that two cures have already resulted and that other cases are rapidly improving. The same report for 1910-11 speaks of a Carnival Exhibition organized by the Bureau of Health at which pictures are displayed with a view to the instruction of the people in the prevention of tuberculosis. In 1911-12 it is reported that the systematic campaign against tuberculosis is now largely in the hands of the Philippine Anti-tuberculosis Society, which was first organized in 1910, also that the Bureau of Health has set

aside two wards at the San Lazaro Hospital for the treatment of tuberculosis, and that it continues to maintain its tuberculosis camp at Baguio. In 1913 the Director of Health makes the statement that it is doubtful whether any country has ever reaped such large returns in improved health and reduced mortality with so small an expenditure of funds as has been realized in the Philippine Islands. The San Juan del Monte Sanatorium at Rizal, which is conducted by the Philippine Anti-tuberculosis Society, is first mentioned in the 1914 report, from which publication it appears that there were 215 admissions for tuberculosis at this sanatorium during the year and that 77 cases were cured or apparently arrested.

At the naval station at Guam a hospital for tuberculosis was opened in 1916.[1] To make the most of the limited facilities of the institution it is proposed to keep a certain number of mild or incipient cases for a limited time, endeavor to build them up by rest and good food and replace them periodically by other groups of patients.

It is, of course, quite possible for Europeans to become cured of tuberculosis in a hot and moist climate. Robert Louis Stevenson is a conspicuous example of such cases. It is stated that the pulmonary tuberculosis in his case was found to be arrested and fibrous after death from another cause. Naturally, however, the majority of the class who can afford the expense will do better to leave the seacoast for some elevated region with drier soil and air and a lower temperature.

Wherever mountains or elevated plateaus are accessible in the tropics health resorts spring up, as in the foothills of the Himalayas, in many mountainous islands, such as

[1] Annual Report of the Surgeon General of the Navy for 1917.

Réunion, in Ceylon, Madagascar and Brazil. The table-lands of the Andes in South America are in high repute for the climatic treatment of tuberculosis. Treutlin states that in Bolivia the number of cases of pulmonary tuberculosis seems to diminish as the altitude increases and cites cases of patients coming from the coast in bad condition who rapidly recover at La Paz. He recommends this town for the climatic treatment of European consumptives.[1]

Morales[2] says that miners from Chile and Peru recover from tuberculosis in the dry and sunny climate of La Paz, but that cases of tuberculosis among the natives have an extraordinarily acute and deadly character. The pretended immunity of the inhabitants of high altitudes to the tubercle bacillus is, he says, only an illusion. He had claimed that the tubercle bacillus was capable of adaptation and that "if at the beginning it had been unable to live at this height of 3629 metres, as was eloquently proved by the many tuberculous individuals who had been cured there, it was very possible that in time the bacillus would accustom itself to the new medium in which it was placed and would give origin to a new strain capable of living in climates of altitude, while its congeners from the coast were perishing." That is to say, the reason why consumptives from the coast improved at La Paz was not that the climate favored an increase of their resistance, but that the micro-organisms which they brought with them were unable to live at that altitude! Morales thinks that he has proved this point because cultures of tubercle bacilli sent him from Europe did not infect guinea pigs at La Paz, though the virus from indigenous cases was very deadly for these ani-

[1] Deutsch. Archiv für Klin. Med. Vol. 100, 1910, p. 88.

[2] Revista de Hig. y de Tub. Valencia. Vol. 2, 1913. Abstr. Internat. Zentralblatt für Tub. Forschg. Vol. 8, p. 28. See also: La Semana Medica, Buenos Aires. Vol. 21, 1914, p. 335.

mals, dismissing with scanty consideration the obvious explanation that these cultures had lost their pathogenicity during the long journey.

This is dangerous doctrine, for the natural inference from it would be that the natives of high altitudes will not be readily infected by contact with the incoming consumptive. Furthermore, if the tubercle bacillus of the coast is "capable of adaptation" to the high altitudes, there is danger of the inference that the tuberculosis of the newcomer will in time assume the deadly character of that of the native; hence a new dread for the unfortunate patient and the unnecessary discrediting of a climate which is no doubt a valuable one for the treatment of tuberculosis.

Vargas[1] remarks that tuberculosis has invaded the highlands of Colombia, which a few years ago were almost free of the disease. He states that in the latter part of the nineties of the last century cases of pulmonary tuberculosis were shown in the hospitals of Bogota as pathological rareties, but that tuberculous peritonitis and meningitis were common, the course of tuberculosis in the native being characterized by rapid cavity formation, miliary forms and meningitis. Correspondingly he finds that while tuberculosis acquired elsewhere is remarkably benefited by the mountain climate, the tuberculous native is little helped by treatment. He explains this as due to the fact that these patients are acclimated and therefore do not receive benefit from the climate. Evidently, however, here as elsewhere, the imperfectly immunized are subject to the acuter types of tuberculosis.

Samanez[2] states that Arca has shown that during the "War of the Pacific" tuberculosis caused a greater number

[1] Jour. Am. Med. Assn. Aug. 30, 1919.
[2] La Cronica Medica (Lima). Vol. 26, 1909, p. 393.

of deaths among the Peruvian soldiers than the forces of the enemy. According to Samanez the Peruvian army is almost exclusively composed of Indians. In the period from 1904 to 1909 inclusive nine per cent. of conscripts were rejected on physical examination for entrance into the army and, although he regards the examination as defective, 33 per cent. of the rejections were for tuberculosis. The incidence of tuberculosis is worst in the initial period of military service. From 1903 to 1909, 2071 soldiers were discharged for tuberculosis out of a total of 3136 discharges, or 66 per cent. Of these 850, or 41.3 per cent., had service of less than six months and 507, or 24.4 per cent., of less than one year. In the year 1908, 222 soldiers were discharged for tuberculosis and 44 (or 29.6 per 1000) died of the disease in the garrison of Lima, which has an average monthly strength of 1485, the average monthly loss being 23, of which number 19 were discharged and four died, a ratio of monthly losses of 15.48 per thousand of strength. The mortality from tuberculosis in Lima in 1906 was for the white race 3.5, black 5.7, mestizo 5.9, yellow 28.0, Indian 23.7 per 1000 inhabitants.

The high percentage of rejections for tuberculosis on entrance examinations and the large percentage of early discharges for this diseease show that the Peruvian conscript often brings his tuberculosis with him from his native mountains. But that not all of the scattered population, perhaps not all of the isolated mountain villages, have been brought into contact with the tubercle bacillus is quite possible and, if it is the case, would account for the deadly nature of the disease among the natives when it does occur. Dryness of the climate and a clear sky not only favor the dessication of the tubercle bacillus, but also invite to an

outdoor life, and therefore tend to prevent the spread of tuberculous infection. We have already seen, however, that the dryness of the South African climate did not protect the natives from tuberculosis, and it now appears from the facts just cited that altitude also can not be held to exercise any protective influence.

The central plateau of Mexico has a reputation for the cure of tuberculosis. Mexican medical writers claim that tuberculosis diminishes regularly in percentage of incidence with increasing altitude.[1] What the real facts are could be most easily determined by means of the tuberculin test. They probably do not differ materially from those obtained in the Andes. It is important not to ascribe to conditions of climate or altitude a low incidence of tuberculosis due to sparseness of population and infrequency of communication with more highly infected centres. The conditions in the southern part of the Rocky Mountain plateau of the United States are very similar from a climatic point of view to those of the Mexican highlands. It is not proposed to consider this subject here, but it may be remarked that while residence under favorable conditions in the dry climate of the western mountain regions of the United States has an undoubtedly beneficial effect upon the large majority of not too far advanced cases of tuberculosis, no one would venture to make for it such claims as those advanced for the highlands of Mexico and the Andes.

The only relatively hot and dry region in the tropics which could be considered as a health resort is the northern half of Queensland, a colony which has acquired a considerable reputation as a place for the successful treatment of

[1] Des diverses Formes de la Tuberculose selon les differentes Altitudes au Mexique, D. Mejia, Proc. Eleventh Internat. Med. Congress. Vol. 3, 1894, p. 117.

tuberculosis and is visited by many consumptives from abroad in search of health, mainly from the United Kingdom.

It seems to be the practice in tropical colonies to repatriate at once cases of tuberculosis that develop in the European civil and military officials and in the European soldiers. Something is to be said for the at least temporary advantages of a change of scene, of a visit to one's home and of the stimulus of a change of climate even though the climate relinquished is superior to that of the individual's native land. It is evidently imperative to send away a patient of any status who firmly believes that the climate in which he has lived is fatal for his disease. This idea, it may be mentioned in passing, is derived from the belief that because the natives die of an acutely fatal tuberculosis the European, or American, who has tuberculosis is destined to die in the same way, the idea, in other words, that the type of the disease is determined by the geographical location and not, as is the fact, by the degree of immunity. The physician is sometimes not without responsibility for the dissemination of such notions.

It is the custom in the United States Army to send home as speedily as possible soldiers in whom tuberculosis has been diagnosticated. This is as it should be, for once that diagnosis is made the soldier will as a rule be useless thereafter for tropical service. But care should be taken not to make such a diagnosis without good and sufficient reason. An instance has been known in the Philippines of what seemed to be a veritable epidemic of cases with sputa positive for tubercle bacilli. Some of the individuals were returned to the United States — there were, it is believed, some real cases of tuberculosis among them. With regard

to the others a legitimate doubt was felt on account of their number and the absence of other signs of the disease, and nothing was done, with the result that tuberculosis did not declare itself. In such cases one is authorized to assume that either the bacillus found was not the tubercle bacillus or that the sputum submitted was not that of the individual in question. It is not at all uncommon, however, for soldiers who leave the Philippines with sputum positive for tubercle bacilli and with the other signs of an active tuberculosis to arrive at Fort Bayard with negative sputum and the signs of an arrested lesion.[1] No doubt no imposition had been practised nor any fault of diagnosis committed in the great majority of such cases. The fact of so speedy an arrest is to be explained by the supposition that there was but a slight lapse in an originally high immunity from which recovery was made on the long sea voyage. Such facts constitute a manifest confirmation of the view that tuberculosis appearing in the tropics is determined as to its character by the previous experience of the individual as respects contact with infection quite independently of the situation of the locality in which the disease became manifest. It may, however, be possible that its development was in some way ascribable to tropical conditions that depress the general health. In other words, the individual might not have had manifest tuberculosis if he had not been in the tropics, but the form and severity of the tuberculosis was the same as it would have been if his health had become equally impaired at home.

In civil practice, tuberculosis being determined to be present in a given case, the first question that arises is has

[1] The General Hospital at Fort Bayard, New Mexico, first established in 1899, was until the late war the only sanatorium devoted to the treatment of tuberculosis in the U. S. army.

the patient sufficient means to permit a long journey and a continued residence in remote parts without the necessity of exerting himself? If not he will fare much better if he applies his funds to secure the best attainable conditions at home. Unless the change of residence will undoubtedly result in "physical promotion" it were better not made. There are very few places where a consumptive, not hopelessly advanced in his disease, may not hope for at least a very considerable prolongation of life provided that he is wisely instructed and faithfully carries out his instructions. The physician often errs in assuming more knowledge on the part of the patient than he possesses. The minutiae should be inquired into, not only the symptoms, but also the ideas of the patient as to what he should do to help himself. It is necessary to win the confidence of the patient and to endeavor to dissipate what are often quite unnecessary apprehensions. Some have unfortunately been taught that swallowing sputum leads inevitably to intestinal tuberculosis and wear themselves out in anxious endeavor to prevent this. Others may have the idea that expectoration is nature's method of eliminating poisons, or again that expectoration not immediately brought up may infect new parts of the lung and may consequently exhaust themselves in efforts to get rid of mucus at the first indication of its presence. The writer has repeatedly seen negro patients who cover their heads with the bedclothes when desirous of sleeping. This is a practically universal habit in the negro race not only in the United States, but in Africa. It is said to be prevalent also in some races of India. Of course, nothing could be more prejudicial to a treatment of which fresh air is the very foundation.

The inhabitants of Mayotte, one of the islands of the Archipelago of Comores, in the Pacific Ocean, have appar-

ently evolved a method of their own for treating consumption, a disease which is much feared. According to Blin· tuberculosis is considered curable in its early stages, and is always treated as follows: At first the patient is given the most absolute rest for a month or more. During this time he eats every day a dish of young chicken, melted butter and cardamon seeds. To relieve the respiration a mixture of flour and yolk of eggs is spread upon his chest. Deep inspiration being painful, the chest is constricted below the nipples by a cloth binder so as to prevent full expansion. Here are some very good ideas, absolute rest, good food — even the constriction of the chest has respectable medical authority for its support — but mixed with superstitious or unreasonable practices, such as the external applications.

The author does not report as to the success of this treatment, but one can hardly expect a good result for the reason that even though carried out in a manner more conformable to enlightened practice it must almost necessarily be begun too late. That is the evil of treatment at the hands of the non-expert. However judicious it may be, it is not begun until the indications of advanced disease are present. In the tropics as elsewhere the desideratum is to detect the disease in its incipiency and to institute treatment before the layman can make the diagnosis or the patient become conscious of failing powers. In no disease is the patient more dependent upon the guidance of the skilled physician and in no disease has the physician greater responsibility for early detection and accurate diagnosis. Of course the "tripod of treatment" in the tropics is the same as elsewhere — rest, good food and fresh air. The ability to be out of doors during the year gives a cer-

[1] Ann. d'Hyg. et de Med. Colon. Vol. 7, 1904, p. 335.

tain advantage in the tropical treatment of tuberculosis. On the other hand, the heat and the insects make for restlessness. Repose of mind is as important as repose of body. It is especially important to reassure the patient as to the possibility of improvement in view of the widespread prevalence of the idea that the tropical climate forbids recovery. One who believes that he is doomed can not be expected to do well. Recounting the history of others who have recovered helps greatly. After cures have been effected it is easier to keep hope alive. Of course benefit from rest, food and fresh air depends upon the presence of an immunity. It is futile to expect a manifest primary tuberculosis to be benefited by such means.

One word as to the responsibility of the physician who has the care of the patient in the interim, while he awaits the arrival of the ship or before he goes to the mountains. If one really wishes to help no day should be lost, for time is precious. The patient should be given as careful instruction and be restrained as sedulously from over-exertion as would be the case if he were to remain constantly under treatment. This counsel is given because it has sometimes come to the knowledge of the writer that those who have temporarily the care of the tuberculous seem to take their responsibilities altogether too lightly. One of the greatest mistakes in the treatment of tuberculosis is the belief that overdoing or other neglect of precautions can be atoned for by increased care in the future.

CHAPTER X

TUBERCULOSIS OF THE AMERICAN NEGRO AND OF THE AMERICAN INDIAN

It is commonly said that the negro of the United States was free from tuberculosis so long as he was a slave, but became tuberculous to an alarming extent when he came into contact with civilization. For one who has perused the preceding pages it must be evident that this statement is incorrect. Though a slave, the negro was not out of contact with civilization. On the contrary many negro slaves were city-dwellers, and those who remained upon the plantations were many of them in the closest touch with the whites. The negro children played with the white children, the men were coachmen, jockeys, valets, barbers, body servants and cooks, the women cooks, children's nurses, waitresses, chambermaids and washerwomen. While many of the hands of course had not the opportunity to fill any positions of this kind there can be no doubt that, if the negro before the Civil War had indeed been uninfected with tuberculosis, the opportunities for at least occasional infection were such that epidemics of primary tuberculosis must have resulted. No doubt experiences of such a kind occurred in the early days of the slave traffic but long before the recollection of any one now living the negro race must have become thoroughly enough tuberculized so that the serious manifestations of tuberculous disease as it appears in unprotected individuals would be rare.

The earliest accessible records are those of the health office of Charleston, South Carolina, which extend from the

year 1822 to the present time. By reference to the chart compiled from these records[1] (Chart No. 4) it is seen that the mortality from consumption for the period 1822 to 1830 was high, but nearly equal among the white and the colored population, and that while it declined in the following decades it remained nearly equal. From 1865 on however the difference between the two races becomes enormous. On the whole the white death-rate continues to decline but that of the negro shoots up so as to be two or three times as great as that of the whites, and there is no longer a parellelism in the fluctuations of the two rates. There can be no question that before the Civil War the negro was in

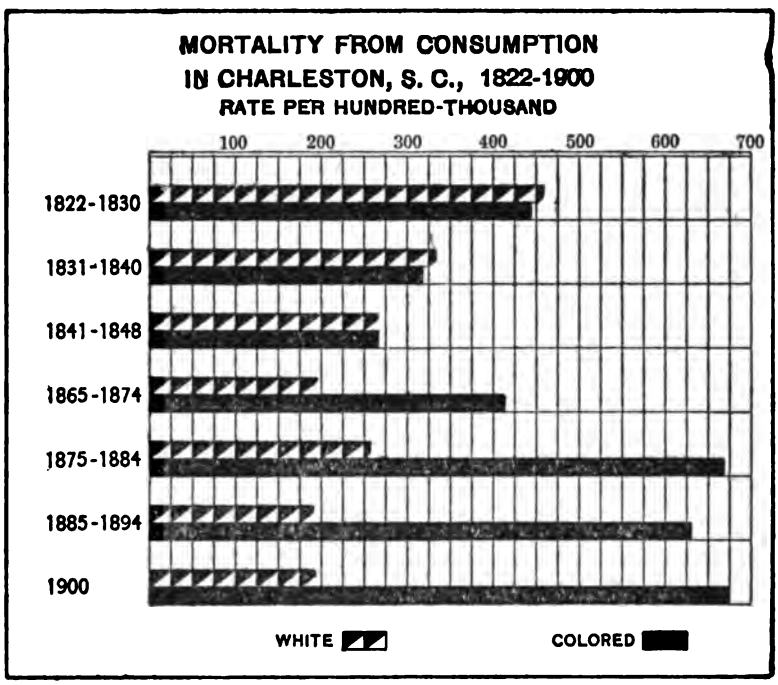

CHART No. 4.

[1] Tuberculosis among the Negroes, Thomas J. Jones. Proc. 2d Annual Meeting National Tuberculosis Association. 1906, p. 97.

the same condition as respects infection with tuberculosis as the whites, in other words, he was tuberculized practically to the same degree as his master; the almost identical mortality-rate in the two races proves this beyond question. The frightful mortality after his emancipation must therefore be explained on other grounds than that of the primary infection of a completely non-immunized population.

The negroes were first used as soldiers in the Union army in 1863.[1] Immediately after their enlistment during each of the months of July, August and September, nearly one-half of the command is reported to have been sick. From this highest sick-rate there was a steady decline and the health of the negro troops improved so remarkably under service conditions that during the last quarter of the year ending June 30, 1866, their sick-rate was somewhat less than that of the white troops. Their death-rate, which was high at first, about 25 per thousand of strength during the first four months of service, declined to a minimum of 3.18 per 1000 in May, 1866, but was always higher than that of the white troops. This improvement of untrained troops under conditions of active service in time of war would be remarkable enough if the command had been of essentially the same composition in 1866 as it was in 1863. But this could not have been the case for the strength of the colored forces gradually increased from 2250 in July, 1863, to a maximum of 105,009 in June, 1865. There must therefore have been a frequent and large influx of recruits and the improvement of the individual soldiers in health must have been more rapid in many instances than appears at first sight.

[1] Med. and Surg. Hist. of the War of the Rebellion. Part 3 Medical Volume, p. 24.

During the five and one-sixth years covered by the statistics of the war there were 13,499 admissions among the white troops for consumption, with 5286 deaths, being at the rate of 6.1 and 2.2 per 1000 of strength respectively. Many taken sick with other diseases or reported at first under other diagnoses were discharged for consumption. There were 20,403 discharges for this cause among the white troops. Among the colored troops the cases admitted as of consumption were 1331, the deaths 1211 or 7.2 and 6.3 respectively per 1000 strength. There were 592 discharges for this disease. The relatively large number of deaths was due, the compiler of the statistics states, to the negroes' homeless condition — they could not be discharged in order to go home.

After the Civil War the annual reports of the Surgeon General for some years give but little information of value concerning the relative incidence of tuberculosis. In 1867 the average annual strength of colored troops was 6561, their admissions to sick report 19,964, each man on an average having been admitted three times during the year, but the white soldiers, with average strength of 41,104 and admissions to sick report numbering 122,181, had nearly as high rates.

In 1884 the statement is made with regard to consumption that while there appears to have been no material difference between the two races in admission rate, the combined rate of loss by deaths and discharges has been somewhat in favor of the white troops. In 1885 the white soldiers numbered 21,944, the colored 2194; the ratio per 1000 of strength of admissions for tuberculosis is given as 8 for each class.

The annual report of 1898 states that in 1896 the ratios of admission and non-effectiveness were considerably lower

in the negroes than in the white troops. This report gives the following ratios per 1000 of strength for the decade 1886-1895 for tuberculosis of the lungs. White soldiers, admissions 2.93, discharges 1.52, deaths .44; colored soldiers, admissions 3.93, discharges 1.85, deaths .84; Indians (1891-1894), admissions 25.39, discharges 11.44, deaths 7.04. The annual report of 1905 remarks for the year 1904 that admission and discharge rates from disease for white troops were in excess of those for negroes while the death ratio was 2.82 per 1000 less than that for colored troops. Ratios of admission for tuberculosis were, whites 4.41, colored 6.41.

TABLE No. 4

ADMISSIONS FOR PULMONARY TUBERCULOSIS, ENLISTED MEN, U. S. TROOPS, PHILLIPPINE ISLANDS, BY RACE

YEAR	WHITES			COLORED			PHILIPPINE SCOUTS		
	Mean strength	Number	Ratio per 1000	Mean strength	Number	Ratio per 1000	Mean strength	Number	Ratio per 1000
1908	9711	58	5.97	2260	16	7.08	5085	20	3.84
1909	11685	55	4.71	3159	5	4.31	5539	31	5.77
1910	12277	59	4.81	No colored troops were in the Philippines in 1910 and 1911.			5302	15	2.95
1911	12454	46	3.69				5372	11	2.09
1912	11006	45	4.09	1351	12	8.88	5407	26	4.81
1913	9377	56	5.97	1811	13	7.18	5096	32	6.28
1914	8375	52	6.21	1878	19	10.12	5020	26	5.18
1915	10493	61	5.81	1341	13	9.69	5505	25	4.54

Admissions to sick report furnish the best guide to the facts as to tuberculosis because many are discharged who die at a later time of the disease, so that the deaths in service do not represent the whole mortality, but in part the mortality of those who having no home to go to are forced to remain in the service to die. The negroes are probably so situated in a larger percentage than the whites.

Table 4 gives the ratios of admission for pulmonary tuberculosis in white and colored soldiers in the Philippines

TABLE No. 5

ADMISSIONS FOR PULMONARY TUBERCULOSIS, ENLISTED MEN, U. S. TROOPS IN CONTINENTAL U. S., EXCLUDING ALASKA, AND IN HAWAII, BY RACE

Year	UNITED STATES						HAWAII					
	WHITE			COLORED			WHITE			COLORED		
	Mean Strength	Number	Ratio per 1000	Mean Strength	Number	Ratio per 1000	Mean Strength	Number	Ratio per 1000	Mean Strength	Number	Ratio per 1000
1908	62263	228	3.66	3143	21	6.68	281	1	3.92			
1909	55163	221	4.01	1961	5	2.55	1087	2	1.97			
1910	52694	153	2.90	2986	4	1.34	1225	4	3.28	Colored troops first served in Hawaii in 1913		
1911	52367	164	3.14	2933	10	3.41	2014	3	1.49			
1912	55886	164	2.94	2488	4	1.61	3376	5	1.48			
1913	57912	150	2.59	1696	6	3.54	5082	15	2.95	1048	9	8.59
1914	59534	138	2.32	1828	6	3.28	6252	18	2.88	1719	3	1.75
1915	61286	154	2.51	2439	3	1.28	6709	22	3.28	1863	6	3.22

compared with the ratio of the Philippine Scouts for the years 1908 to 1915, inclusive. Table No. 5 gives the same data for white and colored soldiers in continental United States and in Hawaii. Both tables are unfortunately incomplete in that the colored troops did not serve in the Philippines in 1910 and 1911, nor in Hawaii until 1913. The number of white troops considered is sufficient, if we except Hawaii, to give ratios of some value. The ratios of the colored troops being based on a small strength fluctuate from more or less accidental causes so that they can only be accepted as a rough approximation in a general way to the true facts. We conclude from a study of these tables that the white troops have more tuberculosis in the Philippines and less tuberculosis in Hawaii than in the United States and that the admission rate for tuberculosis of the colored troops fluctuates in the same way between the three stations, but is on the whole always higher than the white troops, while the ratios of the Philippine Scouts are lower than those of both white and colored troops in the Philippines. The tuberculosis death-rate in immunized peoples rises and falls in a general way with the general death-rate. We may therefore not only obtain an idea of the comparative healthfulness in general of the different stations for the white and colored troops but may seek also a confirmation of the above facts as to the incidence of tuberculosis by considering the death rates of the two classes of troops. For the white troops the general death-rate per 1000 of strength for 1904-1916 was 5.08 in the United States, 6.14 in the Philippines and 3.03 in Hawaii. For colored troops it was 8.51 in the United States, 7.56 in the Philippines and 5.13 in Hawaii, these figures thus pointing to the same conclusions as were reached by studying the admission ratios for tuberculosis. But the numbers of the

colored race concerned are far too small to enable definite conclusions to be drawn from them and it may be well to consider briefly some statistics drawn from large centres of population.

TABLE No. 6

DEATH RATES FROM PULMONARY TUBERCULOSIS IN THE DISTRICT OF COLUMBIA PER 1000 IN FIVE-YEAR PERIODS 1860-1914 AND FOR THE YEARS 1915, 1916 AND 1917.

Period	White	Colored	Combined
1880—1884	3.17	6.96	4.44
1885—1889	2.88	7.05	4.26
1890—1894	2.48	5.29	3.41
1895—1899	1.97	4.68	2.83
1900—1904	1.83	4.92	2.79
1905—1909	1.55	4.94	2.55
1910—1914	1.27	4.53	2.18
1915	1.14	4.07	1.95
1916	1.05	3.74	1.79
1917	.93	3.12	1.50

Table No. 6, from figures furnished by the Health Department of the District of Columbia, which those who are best able to judge consider very accurate, gives the death-rate of the whites and of the colored population of Washington for pulmonary tuberculosis for a considerable period. From this table it appears that the death-rate of the colored people is always much larger than that of the whites. But the death-rates of the whites fall steadily through the successive periods or years for which the figures are given. Those of the negroes on the whole also fall, that of the year 1917 being less than half that for the five years 1880-1884. It is quite evident that the same causes (here no doubt hygienic betterments) are in operation to lesson the mortality rates of both of the two races.

The improvement in the mortality of the negroes is of especial significance on account of the very bad housing

conditions which prevailed after the Civil War. "During the War the slave deserted the plantation to find refuge and liberty in the District of Columbia, the only spot at that time in the United States that offered such a boon. The rapid influx of a negro population estimated to have been between 30,000 and 40,000 imperatively demanded immediate accommodation. In consequence of this necessity hovels of every description arose as if by magic."[1] This abnormal growth of a class of people destitute of means and education and ignorant of physical laws led to a very high mortality. "The general death-rate in 1875 among the white population was 21.04 against 42.86 per 1000 in the colored." Through the efforts of many public-spirited citizens an investigation was made of the insanitary habitations mostly inhabited by negroes, which were hidden away in tortuous alleys in the middle of city blocks and in other out-of-the-way places. There were 286 of such "alleys" on which lived 19,076 people. The health conditions were found to be indescribably bad. This inquiry led to the condemnation and removal of the worst of the shanties and hovels, and to the formation of the Washington Sanitary Improvement Company, which erected numerous sanitary dwellings for the use of the poor, both white and colored, at a moderate rental. In 1907 the company owned 200 houses, occupied by 400 families.

In connection with the statistics obtained from the army serving in the tropics we will compare the general mortality and the mortality from pulmonary tuberculosis of the two races in six large cities with a large negro population.[2]

[1] History and Development of the Housing Movement in the city of Washington, D. C. G. M. Kober, Washington Sanitary Improvement Co., 1907.

[2] Negro Population in the U. S., 1790-1915, Cummings. Census Bureau, 1918.

TABLE No. 7

DEATH RATES PER 1000 OF WHITE AND NEGRO POPULATION IN SIX LARGE CITIES, U. S. CENSUS 1900 AND 1910, AND THE DEATH RATES OF THE SAME FOR PULMONARY TUBERCULOSIS ACCORDING TO CENSUS 1910.

	Negro population	Death-rate negroes all causes, per 1000 negro population		White population	Death-rate whites, all causes, per 1000 white population		Death-rate negroes pulm. tuberculosis per 1000 negro population	Death-rate whites pulm. tuberculosis per 1000 white population
	1910	1910	1900	1910	1910	1900	1910	1910
New Orleans...	89262	32.8	41.	249403	17.2	21.2	5.03	1.82
Washington....	94446	29.1	31.	236128	15.8	18.3	4.70	1.02
Baltimore.....	84479	30.6	33.5	473387	17.2	19.2	5.42	1.72
Philadelphia...	84859	26.9	30.2	1463371	16.8	20.4	5.28	1.74
Boston.....	11591	23.3	26.9	548083	17.1	20.3	5.21	1.99
Chicago	44103	24.3	23.6	2139037	15.	15.2	5.06	1.52

It will be noted in this table that the general mortality of both races is less in all of these cities in 1910 than it was in 1900 (except in the negro mortality of Chicago, where the unusually low rate for 1900 is somewhat increased in 1910) and that while the mortality of the negro everywhere considerably exceeds that of the white man it bears a pretty constant relation to the latter and is evidently governed by the same laws. It also appears that New Orleans, with its subtropical climate, which might be expected to be best suited to a race which originated in the tropics, has a considerably higher general mortality for them than Boston and Chicago.

Evidently the general health of the negro improves as he goes northward, a result hardly to have been anticipated, which is probably explained by freedom from the diseases of warm countries, malaria, hookworm and the like, to which the negro, as for the most part a common laborer, is more exposed on the average than the white man, the rate of whose mortality is practically the same in New Orleans, Baltimore and Boston. The diminished mortality in the north can not be explained by the supposition of a greater incidence of diarrhoeal diseases of children in the south for the percentage of negro deaths under five years of age is lower in 1910 and in 1900 in New Orleans than in any other of the cities in the table except Chicago. Washington has the lowest general mortality rate among the whites of all the coast cities, in both censuses, but its rate does not compare favorably with that of Chicago especially in 1900. But when we consider the death-rate for pulmonary tuberculosis we see that Washington occupies a very exceptional position, the mortality being much less for both races than that of any of the other cities. This low rate can hardly be due to climate, for the rate of Baltimore, but

about forty miles distant, with practically the same climatic conditions, is very much higher in both races, Boston has a higher rate than New Orleans and the rates of New Orleans and Chicago are almost identical for the negro population. The spaciousness of Washington, the almost complete absence of factories and the large admixture in the white population of government employes who are free from the strains of the competition of industry and business life would perhaps account for the low rate so far as the white race is concerned. The number of negroes who are government employes, while much smaller than that of the whites, may have a perceptible effect in the reduction of the negro death-rate from tuberculosis. Now while the tuberculosis death-rate among the negroes is much greater than that of the whites everywhere and varies in general with that of the whites, its variations are smaller. For example, the excess of the Boston rate over the New Orleans rate is greater in the whites, that of the Boston rate over the Washington rate is very much greater in the whites, the rate for Boston being nearly double that for Washington.

It will be unwise to attempt to draw definite conclusions from fractional variations in the rates of the individual cities. We may say, however, that it would appear that northern cities are more favorable to longevity than southern cities but that climate has little if anything to do with the comparative mortality from pulmonary tuberculosis in large cities. Whatever it may be that makes the negro peculiarly susceptible to tuberculosis operates about the same way in city-life everywhere.

Because of his color the negro is barred from much productive industry. As he therefore can not compete with the whites in earning capacity, he is relegated to the worst

habitations in the most insalubrious locations and to arduous or poorly paid toil everywhere, the peculiar disadvantages under which he labors being naturally more conspicuous in their effect upon health in the crowded centres of population. If his death-rate from pulmonary tuberculosis could be compared with that class of the white population which lives under similar economic conditions, it is believed that there would be found to be little difference. W. H. Baldwin[1] says: "It is not safe to assume that the difference in mortality (between the whites and the negroes from pulmonary tuberculosis in Washington) is due to racial susceptibility, for even a superficial study of conditions discloses bad housing, improper food, ignorance of the nature of disease, and lack of care as to proper medical treatment among the colored people to a degree that raises the question whether whites subject to the same influences would not suffer as much".[2] And Cummings[3] remarks that it is not improbable that among certain classes in urban communities the mortality from specific causes (tuberculosis, pneumonia and organic heart disease) is as high among whites as among negroes, but that no adequate data are available for determining mortality rates for the different social or economic classes.

[1] Journal of the Outdoor Life. September, 1907.

[2] "Tuberculosis is known to attack without any racial preferences. The small differences observed among the various divisions of mankind in regard to their liability to tuberculosis are traceable to social and economic causes. Moreover the variations displayed by the different groups of white humanity, such as the differences in the incidence of the disease between city and country dwellers, rich and poor, those engaged in indoor and outdoor occupations, persons active in a dusty atmosphere as compared with such as are working in clean, airy shops and the like, are just as great, often greater than the differences observed in the white, black, red, or yellow races". Fishberg, The Jews, p. 290.

[3] Loc. cit.

According to Gebhardt,[1] however, the statistics of Hamburg are compiled to show the relative rates for disease and death as compared with the income of the individual. The figures obtained in that city show that of persons with an annual income of over 2000 marks ($500) fifteen per 10,000 die of tuberculosis, but that of those whose income is less than 2000 marks the death-rate is at least 40 per 10,000. If we may apply these facts to the negroes of the United States we will account for more than one-half of their mortality from tuberculosis by their poverty which is harmful in part by reason of poor and insufficient food, but probably much more on account of bad housing, overcrowding, etc. In Edinburgh, Williamson[2] found that the number of cases of tuberculous disease increases as the house accommodations become more limited. "Pulmonary tuberculosis is a disease in which 70 or 80 per cent. of cases occur in houses of three rooms and under; the number of cases is larger in two-room houses than in three and larger in houses of one room than in those with two." In studying such statistics we should not fail to consider that, however important over-crowding and the bad ventilation which almost necessarily results may be for the development of tuberculosis, in many instances the resort to inferior accommodations is the result, not the cause, of the disease, that is, the family may be obliged to live in one room because the father is unable to work on account of tuberculosis. Such cases do not, however, invalidate the general law that poverty increases the incidence of tuberculous disease. Now in Edinburgh the people who inhabit the smallest tenements are for the most part Scotch, and while some

[1] Cited by Boyd, Annual Report of the Surgeon General of the Navy, 1899, p. 161.

[2] Brit. Jour. of Tub. Vol. 9, 1915, p. 111. Cited by Fishberg, Pulmonary Tuberculosis, 2d Edition, 1919, p. 73.

are doubtless poor because of improvidence or dissipation, on the whole the poorest of the population do not differ very materially from those of somewhat larger means in education, in morality and in their views of life in general. But in the negro race, while there are many who are sober and prudent, of excellent character and in every way good citizens, it is nevertheless true that the majority of the population are extraordinarily untrained, improvident and reckless; so that there must be taken into account not only poverty but a poverty which is tenfold worse because of the failure to make proper use of the scanty means at hand. Viewed in this light the negro's susceptibility to tuberculosis is very considerably due to his unfortunate social position, his improvidence and his neglect of the laws of healthful living. The point which it is particularly desired to emphasize here is that the negro mortality is a relatively stable or constant mortality in the sense that it does not differ greatly according to climate or location, but that, as is shown by Table No. 6, it is a steadily decreasing mortality, which is influenced by the same factors as those that control the tuberculosis death-rate among the white population. In other words, it is the death-rate of a tuberculized population just as is that of the whites.

This point will be made clearer if we turn for a moment to a race in which immunity against tuberculous infection from previous contact with the virus of tuberculosis has been very imperfect or absent. General Orders No. 28, Headquarters of the Army, March 9th, 1891, authorized the recruitment of eight troops of Indian cavalry and nineteen companies of Indian infantry. The number of Indian soldiers on June 30, 1891, was 417; on June 30th, 1892, 780; on June 30th, 1893, 771; on June 30th, 1894, 547. The Inspector General, in his report to the Secretary of War

for 1893, recommends the disbandment of the Indian military organizations, and in 1894 the General commanding the Army states that the object of their enlistment, namely, to ascertain the present and prospective value for military purposes of the several Indian tribes, has been attained and recommends that what he characterizes as "the experiment" of their enlistment should be given up, which was done in that year. It is evident that the experiment was not in general a success so far as creating serviceable organizations is concerned, but it does not appear that the conditions of health among the Indian soldiers constituted one of the reasons for their disbandment. But the ratios of admission, discharge and death of Indians from pulmonary tuberculosis which have already been given are enormously greater than those of the other troops.

In his report for 1893 the Surgeon General speaks of "the increased consumptive tendency to which Indians are so prone when they give up their wild life for a semi-civilized mode of living."

In 1887 several hundred Apache Indians, among whom were comprised some women and children, were confined at Mt. Vernon Barracks, Alabama. According to the report of the Surgeon General for 1896 their death-rate in the first year, 1887-1888, was 54.64 per 1000 and during the second year 48.96, but it ran up during the third and fourth years to 109.69 and 142.84, nearly one-half of which was due to tuberculous disease. At this time great improvement was made in their condition. A new village was built for them and they were placed under the most vigilant sanitary supervision, with the result of bringing the death-rate in 1891-92 down to 109.75, the next year to 80.93 and in 1893-94 to 98.36. The prisoners were transferred to Fort Sill, Okla., in October, 1894, the excessive mortality that had

prevailed among them during their stay in Alabama being one of the chief reasons for effecting the transfer. Here they were assigned land and led a freer life. At the end of their first year at Fort Sill it is reported that their condition was much improved, but that the death-rate continued high, 83.05 per 1000, yet it was thought that a large part of the mortality was referable to infection at Mt. Vernon Barracks. Of a total of 25 deaths, 17 were due to tuberculous disease, and the statement is made that but for the tuberculous infection the death-rate among the Indians would not be high. As has been learned by personal communication with a medical officer who was on duty at Fort Sill during a portion of 1894, glandular affections were very common among these Indians and the deaths were chiefly due to pulmonary tuberculosis.

The report of the commanding officer of Mt. Vernon Barracks for 1893 is contained in the report of the Inspector General of the Army for that year. From this report it appears that the total number of Apache prisoners in 1892 was 343, in 1893, 328. This officer reports a remarkable improvement in the mortality of all diseases except consumption, which he says is the prevailing disease, and seems to progress rapidly and fatally. There were, he states, 27 deaths from tuberculosis in 1892 and 17 deaths in 1893, which would give ratios per 1000 of 78.7 for 1892 and 51.8 for 1893.

From what can be learned of these Indians at Fort Sill it would appear that some progress towards tuberculization had been made during the term of their imprisonment. Unfortunately no data as to post-mortem findings at Mt. Vernon Barracks are accessible, but the high mortality and the rapid and fatal course of the tuberculosis show clearly enough that the Indians had not had that protection against

tuberculosis which long contact with the disease has conferred upon the civilized whites and negroes. Particularly significant is the fact that the highest mortality from tuberculosis occurred not during the first year of imprisonment, but in the third and fourth years, which seems to point unmistakably to infection at Mt. Vernon Barracks.

In 1881 the writer had medical charge for about three months of 2800 Sioux prisoners of war. These Indians had surrendered during the previous winter, after a long warfare. They consisted of two classes, first the "wild" Indian, who had had but little contact with the whites. There were some among the number who were said to have but recently seen a white man's house for the first time. The second class consisted of agency Indians. When the warriors of the first class fell ill it was because they had over-eaten at some feast, the agency Indians were more sickly. Enlarged cervical glands were very common; occasionally a child died with swollen abdomen, the disease probably being tuberculous peritonitis. The pressure of work and the prejudices and fears of the Indians alike forbade a medical survey, but no cases of pulmonary tuberculosis came under observation.

Here was the mingling of two streams, the one kept free of the diseases of the whites by the enforced separation of continuous warfare (for their captivity marked the close of the Sioux wars, save for the abortive outbreak at Pine Ridge), the other contaminated by the diseases and vices of civilization. The writer has frequently seen the scrofulous youths from the Agency, their fleshless limbs fully clad, looking on wistfully at the dances of the warriors in the summer twilight, where braves, stripped to the breechclout, danced on the grass to the music of the tom-tom, reproducing in pantomime their exploits in border warfare

or in horse-stealing, and revealing in many instances a magnificent physique and a boundless vitality, which contrasted cruelly with the listless aspect of some of their spectators.

The two streams became one when the Indians abandoned their tipis and took up their residence in houses under the guidance of agency officials. It is commonly said that the wild Indian was filthy in his personal habits. Certainly no care was exercised to guard against the pollution of the ground about his habitations, but when the contamination became marked the village was moved, so that after all his mode of life was not insanitary in that respect. But when the Indians took up their residence in houses they continued the practices of the tipi, although no longer able to move away from their infected surroundings, a natural consequence of which was a wide dissemination of tuberculosis. The opinion derived from personal observation as to the relatively good condition of the Indian tipi is shared in by Stefansson, who moreover corroborates the view as to the deadliness of house-life for the unprotected Indian in his remarks concerning the Indians of the Mackenzie Valley. He says: "The Indian tipi is not only always filled with fresh air but it never becomes filthy because it is moved from place to place before it has time to become so. The housekeeping methods which are satisfactory in a lodge that is destined to stand in one place only two or three weeks at a time, are entirely unsuited for the log-cabin. Eventually the germs of tuberculosis get into the house and obtain lodging in it. The members of the family catch the disease, one from the other, and when the family has been nearly or quite exterminated by the scourge, another family moves in, and so it is not only the family that built the house that suffers but there passes through the house a procession of other families moving from the wigwam to the graveyard.

In some places tuberculosis has made a nearly clean sweep of the population. This is noticeably true at Fort Wrigley, where we were told that only nineteen hunters were left in all the territory belonging to that post."[1] We may compare here the statement of Hirsch that on the Arabian and Abyssinian coasts consumption among the Bedouins is met with most frequently among those "who have exchanged the tent for a stone house." Of course the extermination of whole families of Indians speaks for a population unprotected by previous contact with tuberculosis. In a thoroughly tuberculized population the mortality from an infected dwelling might be equally high among the young children, but many adults would escape manifest disease. Those of the adults who developed clinical tuberculosis under such conditions would owe their disease to depression of the vitality from bad air and filthy surroundings, non-specific causes of the tuberculous exacerbation which would be equally operative if the dwelling were not infected with tuberculosis. Whether, therefore, the residence of a certain group of Indians in houses is to be regarded as subjecting them to the danger of extermination or as simply leading to a regrettably high incidence of usually more or less chronic tuberculosis depends entirely upon the degree of their previous tuberculization. According to Walker,[1] in 1896, there were 4893 Oglala Sioux (the greater number of the captives already referred to belonged to this band) of whom 741 were tuberculous, and of these 124 died in that year. That is, 148.7 per 1000 were known to be tuberculous and the annual death-rate from tuberculosis was 25.3 per 1000. It is reported by Brewer[1] that tuberculosis was responsible for ninety-five per cent. of the deaths among the Mojaves, that among the Pimas and Maricopas it caused

[1] My Life with the Esquimaux, p. 22.
[1] Cited by Hutchinson, N. Y. Med. Jour. Vol. 86, 1907, p. 624.

sixty-six per cent. of the deaths, and that it is very prevalent among the Hopis and Navajos. But on the other hand the report from another Navajo reservation was that tuberculosis was not very prevalent but was always fatal, and, again, among the Zunis the actual amount is small but the mortality is one hundred per cent. Evidently, then, at least at the time of this report, no single formula expressed the situation of the American Indian as respects tuberculosis. Some tribes were thoroughly tuberculized, others showed the characteristics of a recent acquaintance with the disease in its high fatality. In most of the Indian tribes it would probably be correct to say that tuberculization was progressing but was as yet not complete.

The following table has been compiled from more recent data obtained from the annual report for 1918 of the Commissioner of Indian Affairs:

TABLE No. 8

DEATH RATES FROM ALL CAUSES AND FROM PULMONARY TUBERCULOSIS IN FOUR INDIAN TRIBES.

TRIBE	Population	Ratio all deaths to population per 1000	Percentage deaths from tuberculosis in all deaths	Ratio deaths tub. to population per 1000
Zuni.....	1815	23.1	4.7	1.10
Moqui.....	4225	15.4	20.	3.08
San Juan (Pueblo)..	6500	27.6	22.	6.15
Pine Ridge (Sioux)...	7340	20.1	38.5	7.76

We compare here three tribes which have long inhabited permanent dwellings with one (the Sioux) which has but recently relinquished the tipi for the house. The numbers concerned are too small to furnish ratios of much value. So far as they go, however, they show the Sioux to be more severely afflicted with tuberculosis than the other three

tribes. Why there should be so great a difference between the Zuni and the other two southern tribes, especially the Moqui, the writer is unable to say, except that it may be due to a lesser degree of tuberculization because of the unwillingness of the Zuni to permit close association with strangers. The incidence of tuberculosis is certainly not to be explained by change of mode of life in the southern tribes.

The report of the Commissioner for 1916 states that a large percentage of the Indian mortality from tuberculosis occurs among children, notes that the appearance of tuberculosis in children under two years of age is almost inevitably the precursor of a fatal issue, and goes on to say that strenuous endeavors are being put forth to protect the infants by a campaign of popular education, " baby-shows," visits by a woman supervisor, the issue of popular illustrated educational pamphlets, etc.

Agency or school hospitals or sanatoria increased from four in 1888 to 87 in 1918, with a total capacity of 2411 patients. During 1918, 17,441 patients were treated at these institutions. These facts, which are undoubtedly unknown to the greater part of our citizens disclose the working out of an enlightened policy in obscure and remote places and doubtless under many difficulties of race prejudice and superstitions as well as of scanty funds, which is exceedingly gratifying. This work is already beginning to reap a reward, for Commissioner Sells had the pleasure of stating in 1917 that " last year for the first time in more than fifty years there were more Indians born than died from every cause ". If this good work continues we may no longer speak of the Indian as a vanishing race. It is to be hoped that so far as tuberculosis is concerned the worst is over, and that tuberculization has reached the stage in

which mortality is not out of proportion to morbidity at least so far as relates to the majority of the tribes — where conditions differ so widely it would be rash to draw too general conclusions. The remark that the mortality from tuberculosis is largely among young children is very significant, for, as already remarked, in primary infections the parents would be carried off as well. When children die of tuberculosis and the older members of the family survive we think in general of faulty hygiene in a tuberculized population. In view of the absolute ignorance of the Indian mother as to the proper care of her children the work of education of the Indian Bureau can hardly fail to be richly rewarded in the prevention of other diseases as well as of tuberculosis.

In the past where the Indians have been closely aggregated, as in schools, in army barracks, or in prisons, the result has too often been a prevalence of tuberculous disease which only fell short of an epidemic because not all the individuals exposed to the chance of infection were without a previous immunization. The Indian is often spoken of as pining like a caged eagle when brought into civilized surroundings, as if his illness were of the mind rather than of the body. Those who have read the preceding pages need not to be informed that the reason why he falls a prey to tuberculosis is because he has had no previous vaccination against it.

In view of the wide prevalence of the idea that the high mortality of aboriginal races when in confinement or restricted to narrow limits under civilized conditions is due to psychical causes and the great importance of a correct understanding of this matter the digression will be pardoned if a brief account is given of the fate of the natives

of Tasmania. Power,[1] writing in 1843, says that it was formerly believed that pulmonary consumption did not exist in Van Diemen's Land, which was certainly not true at the time of his writing, whatever may have been the case formerly. Consumption in that climate does not obtrude itself on the attention by its frequency, he says, excepting among the aborigines, in whom it has been the fatal malady by which chiefly their numbers have been reduced to the miserable handful which now remains of them. Their numbers being few, they were restricted to one small island. "Provisions, clothing, dwelling-places and proper superintendents were furnished, but to a wandering race accustomed to rove at will, to procure their food as they pleased and to live where and how they liked, the confinement to a narrow island and the immediate change from their own free and unfettered habits to the more constrained and artificial ones of civilized life proved speedily fatal. They died in great numbers and in the majority of cases pulmonary consumption was the disease under which they sank. An improved system of management by which their present mode of life is made to assimilate more closely to their former habits has of late years been introduced and it is satisfactory to know that the mortality at first observed has during the same period much diminished." But the improvement in their mode of life came too late, for the race is now extinct. A recent writer, commenting upon that fact, ascribes their disappearance to the fact that they were compelled to wear clothes! Here is the record of an experiment which resulted even more disastrously than did the confinement of the Apache prisoners at Mt. Vernon Barracks. There could be no more striking illustration of the danger which threatens the unimmunized race that is exposed continu-

[1] Dublin Jour. Med. Sci. Vol. 23, 1843, p. 83.

ously to the tuberculous infection that contact with civilized life seems always to entail. In this instance the numbers of the natives were greatly reduced before they were restricted to a single island, on account partly of their constant feuds with the whites. Mental depression from captivity was not responsible, therefore, for the heaviest losses nor could it have been the principal cause of the entire disappearance of a group in which there must have been children too young to be affected by the loss of freedom.

It is interesting to compare the experience of the tropical native when exposed to pneumonia and tuberculosis in the mines of South Africa with that of the negro who has been in close contact with civilization. Of 21,000 tropical negroes the death-rate from pneumonia in 1912 in the Rand Mines was 26.30 per 1000; of 190,000 non-tropical natives it was 8 per 1000.[1] A marked preponderance of deaths from pneumonia was observed in laborers during their first months of employment. Of 2031 deaths from pneumonia in 1912, 1199 deaths occurred among those who had been at the mines less than six months, and in 1913 there were 981 deaths out of 1668 among the same class of laborers. From the report of the Crown Mines[2] it appears that the incidence of lobar pneumonia for the five years 1910-1914 was 38.45 per 1000 and for 1916, 24.60 per 1000. The incidence of pulmonary tuberculosis was 19.98 and 26.83 respectively for the two periods, so that evidently the more chronic disease is overtaking and surpassing the other.

The death and case-mortality rates for tuberculosis are not indicative of the incidence of that disease for the rea-

[1] Gorgas, loc. cit.

[2] Report of the Chief Medical Officer, Crown Mines, 1916.

son that of late years hospital trains and ships have been provided to return the tuberculous to their homes. Notwithstanding this fact the case-mortality percentage for tuberculosis other than pulmonary in the period 1910-1914 at the Crown Mines was 53.54 and in 1916 40.00, showing that about one-half of the patients who suffer from this type of tuberculosis were not able to leave the mines after they fell sick and consequently must have had an acute and fatal type of the disease. This is to be inferred also from the frequency with which organs other than the lungs are involved, this fact, as has already been pointed out, being characteristic of tuberculosis of the non-immunized or but slightly immunized individual.

On account of the great fatality of pneumonia and tuberculosis among the tropical natives and of the danger of dissemination within the tropics of tuberculosis by the natives who return with that disease to their homes, the Government ordered that the recruiting of tropical natives from regions north of latitude 22° S. should cease in March, 1913.

Vaughan and Palmer,[1] writing on communicable diseases in southern camps, make the following remarks as to the relative prevalence of pneumonia: "In the south under ordinary conditions of civilian life pneumonia is relatively rare, but when it does appear is highly fatal, and is highly fatal because it is rare." Substitute the word "tuberculosis" in place of pneumonia and the foregoing statement would apply exactly to the American Indian and to the tropical negro. But as thus modified it does not apply to the negro of the United States. The tubercle bacillus was present in the southern camps, without doubt, more con-

[1] Jour. of Lab. and Clin. Med. Vol. 3, 1918, p. 638.

stantly present than the pneumococcus, if in smaller numbers, but we do not hear of epidemics of tuberculosis among the negroes any more than among the whites, in fact the incidence of tuberculosis has been small in both races and is adequately explained by the supposition that what did develop resulted from the activation of the disease that the patients brought with them into the army.

The facts adduced as to the tuberculosis of the negro justify the following conclusions: the negroes as a race in the United States have long been in contact with the virus of tuberculosis. They are probably as well or nearly as well tuberculized as the white race. This is shown by the fact that when they were slaves, when their masters gave regular employment, provided food and to some extent looked after their health, their tuberculosis rates differed little from those of the whites. When their emancipation thrust them unprepared into the struggle for existence their sufferings and errors are revealed in an enormously increased mortality not only from tuberculosis but from other diseases. But becoming soldiers, the negroes were once more provided for and compelled to lead regular lives, and the result became quickly apparent in rapid reduction of their morbidity and mortality rates. The latter has never for long reached the low level of the white soldier, that it should have so nearly approached that level in so brief a time is a triumph for army sanitation and discipline. The contrast between the negro soldier and the Indian soldier is most instructive. In the one case induction into the army leads to rapid reduction of mortality from tuberculosis, better sanitation enables the acquired immunity to assert itself. In the other case the poisons of civilization overwhelm a vigorous race unprepared by previous experience to resist them. The Amer-

ican Indian in his attitude towards tuberculosis resembles the African negro, the American negro has already passed beyond the stage of primary or nearly primary tuberculous infection.

When stationed in the Philippines both the white and the negro soldier suffer an increase in tuberculosis incidence. Neither race compares favorably with the Philippine scouts; acclimatization doubtless plays a role here. Evidently Hawaii is a particularly favorable climate so far as tuberculosis is concerned. Both races among our soldiers have lower rates for tuberculosis than they have at home, on an island the natives of which were once decimated by tuberculosis[1] — a fact that once more corroborates the law which may be deduced from the observations already recorded: climatic influences are negligible factors in comparison with the presence or absence of immunization against tuberculosis.

[1] H. M. Lyman, Hawaii from a Health Point of View, Med. Rec. Vol. 54, 1898, p. 672.

CHAPTER XI

EPIDEMICS OF TUBERCULOSIS

As has been already remarked, chronic tuberculosis of the adult type is unknown in the first years of life. Tuberculosis of the lungs indeed occurs in early childhood but it is of an acute rather than of a chronic type and is usually associated with tuberculous disease of other organs. Not until the sixth year is reached do we find tuberculosis of the lungs which approximates the adult type and even at that age the resemblance is to the rapidly progressive forms of the disease rather than to the relatively benign chronic phthisis. The explanation of the absence of the chronic forms at an early age is, of course, that the power to restrain the multiplication of the tubercle bacillus and to wall off tuberculous lesions effectively by the growth of connective tissue is the manifestation of a degree of immunization which is only attained in the course of some years after infection. As we have already remarked, the alternatives for the young child are either an immunizing infection which does not result in manifest disease, or at most shows itself in affections of bones, joints, glands and skin of a chronic nature, or an acute and fatal tuberculosis. The same is true of the adult if his manifest tuberculosis appears shortly after infection. It follows then that primary infection cannot cause a quickly developing chronic pulmonary tuberculosis. From this point of view the notion that a chronic pulmonary tuberculosis which has recently declared itself, or has but recently been detected, can be traced back to opportunities for infection within a few weeks or months

seems somewhat naïve. We have but to contrast the usual clinical course of such cases of phthisis with the terribly fatal epidemics of primary tuberculosis already described in order to realize that primary infection can not at once produce the former type of the disease.

Many, it is true, speak of massive infections from without and conceive of the childhood tuberculosis as healed, or of a superinfection as taking place though the primary infection persists. Now, it is questionable if there is any such a thing as a massive exogenous infection under natural conditions, that the childhood infection is not obsolete is shown plainly enough by the cutaneous test and to believe in superinfection, at least from relatively small doses, is to run counter to the facts of other chronic infections and is, therefore, forbidden by such analogies, as well as very distinctly proved to be impossible by experiments on animals much less resistant than man.

Epidemics of tuberculosis have been reported occasionally in the literature. The cases are generally found to be cases of more or less chronic tuberculosis of the lungs, the impression as to the epidemic character of the disease having been derived from the fact that they follow one another rapidly in time or occur in a group of individuals which have been in some way closely associated with one another, as inhabitants of the same tenement or workmen in the same shop.

Marfan[1] reports an epidemic of pulmonary tuberculosis in an office in Paris in which twenty-two employes, most of them less than thirty years of age, worked for about eight hours a day. The room was too small, containing but 220 cubic metres of air. The ventilation was very imperfect,

[1] Sem. Méd. Vol. 9, 1889, p. 399.

the windows opening upon courts with no circulation of air. It was badly lighted — the sun penetrating it but little. The floor was old, uneven and full of cracks. The employes were minor clerks with small salary, probably badly lodged and fed. Several of them abused spirituous liquors. In January, 1878, a clerk who had been employed in the room for twenty-four years died of phthisis. He is supposed by the author to have infected the room by spitting on the floor. The room was swept in the morning and the clerks often arrived in time to breathe the dust stirred up by the sweeping. Nothing is said as to what befell the sweepers, who would seem to have been much more endangered than the clerks. But, whatever the fate of the former, during the period beginning November 27th, 1884 and ending July 16th, 1889 thirteen of the clerks who had been employed in the office for from two to 21 and 23 years died in succession of phthisis.

The case has been reported in this country of three workmen employed successively at the same lathe who developed tuberculosis and died one after the other. In another instance several teamsters living together in the same insanitary lodging house developed tuberculosis almost simultaneously, or, which is far from being the same thing, were discovered at about the same time to have chronic pulmonary tuberculosis. Perhaps the most frequent explanation of such occurrences is that the discovery of some cases has led to the general examination of a group that had previously escaped attention and thus to the establishment of the fact that tuberculous disease existed in many of its members. If we depend upon the history furnished by the patient or by his family we shall often be led to believe that the disease is recent, although physical examination shows in a surprisingly large number of cases that even well-

marked and extensive tuberculosis may exist for years without apparently exciting any suspicion of its presence in the minds of intelligent patients and of their friends. Sometimes we may explain such events, as probably in the so-called Paris epidemic, by the exposure of old cases of more or less inactive tuberculosis to the same conditions of bad hygiene. And, again, the bunching of cases may be due simply to a coincidence that may be expected occasionally in so common a disease. In large tuberculosis hospitals it is not unusual to see a group of far-advanced patients carried off at the rate of one, two or three a day when the conditions of weather are particularly trying, while at other periods of the year there may be no deaths for weeks at a time. Naegeli reports an instance in which a dozen or more deaths from miliary tuberculosis followed one another rapidly in the same hospital after which no deaths from this form of tuberculosis occurred for many months. Now the disease in these cases of miliary tuberculosis was undoubtedly in great part if not exclusively secondary to old lesions, and the unusual feature was the simultaneous development of a number of cases of a rare type, a more or less accidental happening, perhaps influenced to some extent by depressing meteorological conditions, since the event occurred in the winter. No one could properly call such terminations of long-standing disease an epidemic. It is equally improper to call recently detected exacerbations in the earlier course of chronic pulmonary tuberculosis an epidemic, however numerous the cases and however apparently good the previous health of the individual concerned.

It is interesting to compare what a master in medicine calls an epidemic of tuberculosis with the so-called epi-

demics of chronic pulmonary tuberculosis. Virchow says:[1]

"In 1849 I reported that in the spring, at a time when typhus generally prevails, intermittent fever, which was widespread in Berlin even before the cholera, developed more and more, associated with large spleen tumors. To this, especially at the end of April and the beginning of May, acute tuberculosis was associated. Tuberculous inflammations of the pia mater in children and adults, of the pleura, the pericardium and the peritoneum, fresh, mostly isolated (miliary) tuberculosis of the lungs, spleen, kidneys, epididymis, bones, brain glands and intestine were more frequently than I ever remember to have seen them. Generally it was not single organs that were attacked, but a large number of tuberculous organs were found at the same time in the same individual, as is usual when tuberculosis appears in great intensity. Especially to be mentioned in this connection is tuberculosis of the liver, spleen, kidneys and serous membranes. Interesting was the complete coincidence of this epidemic with the epidemic of intermittent fever which went so far that the tuberculous had intermittent fever and the patients with intermittent fever upon their convalescence entered into tuberculosis."

The preponderance of miliary forms, the implication of several of the larger viscera in the same case and the tuberculous serositis, all indicate the presence of acute forms of the disease. From Virchow's well-known views it is not to be expected that he would make a distinction between primary and secondary miliary tuberculosis. We can not determine therefore whether or not adults appeared to be attacked by primary tuberculosis. It is altogether probable, of course, that the truly primary tuberculosis was con-

[1] Ueber die Verschiedenheit von Phthise und Tuberkulose. R. Virchow, Verhandlungen der Physik. Med. Gesellsch. in Würzberg. Vol. 3, p. 104

fined to the children, but it should be remarked that in some rare cases of old tuberculous infection the immunity is so completely lost that forms are met with that usually characterize primary tuberculosis. The peculiar feature of this epidemic is the fact that some complication led to such a complete breaking down of the immunity against tuberculosis in a considerable number of cases nearly at the same time. Apparently Virchow connects the epidemic with intermittent fever as its cause. It would seem, therefore, to be an instance of an epidemic infection of other than a tuberculous nature which aggravated to a remarkable extent existing tuberculosis (so far at least as adults were concerned) rather than an epidemic of tuberculosis in the ordinary sense of the word.

At a western military post of the United States Army it was believed in 1912 that an epidemic of tuberculosis was prevailing. Many of the soldiers were affected with an acute bronchitis, with abundant purulent expectoration, and in some cases with well-marked fever. None of the patients were, however, seriously ill, and in none of them were there any discoverable parenchymatous pulmonary lesions. The disease had begun in a certain barrack and there the number of cases was greater and the type of the disease more severe than elsewhere. There seemed to be good grounds therefore for considering it infectious. It was the opinion of the medical officers that the disease was spreading rapidly and ineffectual attempts were made to check it by the disinfection of barracks, bedding, etc. Now, as the writer convinced himself by personal observation, there was no reason to consider the disease (which was really a bronchitis due to streptococcus infection) to be tuberculosis from any of the findings of physical diagnosis. But as an epidemiological problem could not the nature of the affec-

tion have been determined, as respects the presence of tuberculosis, independently of the physical signs in the individual cases? The answer is undoubtedly in the affirmative. We had here an infection which was spreading rapidly and to which those who had been exposed offered little resistance. Infection was rapidly succeeded by manifest disease. Under the circumstances if the infection was tuberculous the disease must have been primary tuberculosis in which case its course must have been quickly fatal. But, as a matter of fact, no deaths occurred; the patients for the most part were not even confined to their beds.

On the supposition that the disease was tuberculosis we have therefore two series of facts that are absolutely incompatible; on the one hand, a dangerous infection that spread rapidly and became manifest disease at once, on the other, fairly good physical condition, a benign course and obscure physical signs. The epidemic, if it was of a tuberculous nature at all, was therefore an epidemic of chronic relatively benign pulmonary tuberculosis, which is impossible.

Primary tuberculosis alone can occur in epidemic form.

CHAPTER XII

SOME PRACTICAL CONSIDERATIONS

The foregoing discussion will have been made in vain if it has not impressed the reader with an increased sense of responsibility as to the care of the uninfected.

The group of the uninfected which we always have with us is that of the young children. It is they who are in especial danger of infection, and it is they in whom the infection appears in its most deadly forms. Yet singularly enough in the popular teachings stress is laid upon the danger of adult infection, or reinfection, which are practically non-existent and comparatively little is said as to the protection of the infant. The importance of separating the child from the open case of tuberculosis has already been referred to, likewise the possibility, if not the great probability, that the apparently healthy mother or nurse is at times a " bacillus excreter ". The old women nurses, with their chronic coughs and their inveterate tendency to taste the baby's food and to put their possibly infected fingers into its mouth on every occasion are a particularly dangerous class. It is said that after two infant children of a royal house had died of miliary tuberculosis it was discovered that their old nurse had a tuberculous infection of the maxillary sinus with a fistulous opening into the mouth through which mucus laden with tubercle bacilli frequently passed.

It would be easy to create a state of mind bordering upon panic if the mothers should conceive the idea that they are in danger of infecting their children; the instructions

which they receive should therefore be judiciously conservative. The best rules are those of politeness which in part are founded on some instinctive desire to avoid a too intimate and possibly dangerous contact with others. That the child is too young to object is not a reason why it should be kissed indiscriminatingly upon the mouth, or why fingers should be rubbed upon its gums without previous sterilization. If the gums are sore from protruding teeth that is a most excellent reason for abstaining from such a practice, for infection is undoubtedly more easily acquired then than at any other time in the history of the individual. It is a good rule to allow no one, the doctor included, to insert a finger into the mouth of the infant except after proper sterilization. Mothers may well be instructed not to feed the child with a spoon which they themselves have used, nor to give it a bone from which they have gnawed the meat, nor to return to it articles wet with its saliva which it has dropped upon the floor, to be, of course, immediately returned to its mouth. The so-called "dirty age" when the child puts everything that it can reach into its mouth is the most dangerous time in the child's life so far as infection with tuberculosis is concerned. Scrupulous cleanliness should be inculcated with at the same time an avoidance of any attempt to attain an impossible condition of asepsis. Of course, no nurse should be tolerated with regard to whom there is any suspicion of active tuberculosis. A physical examination by an expert is the only way in which this possibility can be excluded with any approach to certainty.

Pollak[1] of Vienna found that children over four years of age did not appear to be unfavorably affected in any way

[1] Beitr. z. Klinik d. Tub. Vol. 19, p. 469. See also: Ibid, p. 393.

by the entrance of a tuberculous individual into the family circle, while those of lesser years grew up more delicate than their older brothers and sisters.

Bergmann[1] had very similar results in Sweden. He found that of children of tuberculous families the mortality from tuberculosis reaches 12 per cent. in those exposed to infection in the first year of life and 11.8 per cent. in those exposed during the first four years, but no children first exposed after the fourth year have died of tuberculosis among his cases and no cases of tuberculosis have developed from exposure after the seventh year.

Fishberg[2] found that in the fifth to sixth year of life children in overcrowded tenement houses in New York reacted positively in 65.26 per cent. if their parents were tuberculous, and in 50 per cent. if their parents were not thus affected, but thinks that the proportion of "reactors" is about the same for the two groups from the seventh to the fourteenth year. The opportunities for infection under the conditions of tenement life are evidently so numerous that when the child is old enough to move about freely he is certain to become infected before long. The especial danger of infection from tuberculous members of the family, then, lies rather in the probable large size and frequency of the infecting doses than in much increased probability of infection *per se*. We have seen that the conditions as to tuberculous infection were so bad at Lippspringe in the early part of the nineteenth century that the arrival of consumptives in large numbers seemed to make no difference as to the infection of the population.

[1] Die Gefährdung von Kindern durch tuberkulöse Ansteckung. Dissertation. Upsala, 1918. Abstr. Internat. Zentralblatt f. Tub. forsch. Vol. 12, No. 7, July 31, 1918.

[2] Arch. Pediat. Jan., 1915.

At present the role of the bovine tubercle bacillus is distinctly subordinate to that of the human bacillus in the infections of man, even in our civilivation, and in many countries in which cattle are rare and milk and its products do not form a part of the daily food of the inhabitants, it has practically nothing to do with the dissemination of tuberculosis. Now, if in countries in which milk is not produced all scattering of human tubercle bacilli could in some miraculous way be stopped, tuberculosis would soon cease to exist. But how would it be in a country of milk-drinkers like our own? In the United States no less than in countries such as China, Japan and Africa in which milk does not constitute a part of the food, the opportunities for infection with the human tubercle bacillus are so great that nearly every one becomes infected with the human type before the bovine bacillus is ingested. Hence an immunization which prevents the bovine infection from taking hold. The bovine bacilli, though unable to excite a progressive infection, may nevertheless succeed in reaching the lymph-glands and may be discovered there by biological tests. If manifest tuberculosis of the human type is present, bovine bacilli are usually to be regarded as more or less harmless intruders in an organism that is immunized against them by antecedent infection. In the rare cases in which it is found that one organ contains bacilli of the human, another those of the bovine type, so that the case presents itself as a true mixed infection, the explanation undoubtedly is that the infection with one type was succeeded so rapidly by contact with the other that immunization had not become sufficiently advanced to forbid superinfection. In Weber's cases of infection through contaminated milk it was sometimes found that of a family of children who had been equally exposed only the youngest gave

evidence of infection.[1] Manifestly, here the correct explanation is that the older children had become immunized against a new infection by previous contact with the human tubercle bacillus. In general, bovine tuberculosis is a disease of childhood and the fact that it is relatively rare in a nation of milk-drinkers is one of the best proofs that an immunity against the bovine type is regularly obtained through early infection with the human tubercle bacillus. But supposing that by herculean efforts we had attained the impossible, that we had totally extirpated the human tubercle bacillus; what would be the result? If the foregoing reasoning is correct, evidently what we should have to expect would be that our children, instead of becoming infected with the human type, would receive infections from the bovine bacillus. It is an Utopian dream, in the judgment of the writer, to hope that the tuberculous infection of cattle will ever be totally eradicated. But if this is not done, given the disappearance of the typus humanus, immediately bovine tuberculosis rears its horrid head probably as formidable a menace as tuberculosis of the human type has ever been! The only way to prevent this would be either to give up the cow or to resort to a more conscientious sterilization of all milk, not only as a beverage but as used in butter and cheese in all its forms, than could ever be realized on a large scale. The outlook is therefore doubly hopeless. Civilized man can never escape the dangers of infection with the tubercle bacillus. But if we did escape the dangers of infection, we should also lose the benefits of tuberculization. Supposing that with extraordinary energy and sagacity we banish all tuberculosis from our town and rear an absolutely uninfected group of chil-

[1] Tub. Arb. aus d. Kais. Ges. Amte. Heft 10, 1910, p. 29.

dren. Having passed a childhood under the irksome restrictions that would be necessary, the time must come when they shall be permitted to enter the outside world, for the fear of disease can not remain the paramount consideration during life. As soon as, now adults or adolescents, they leave the sheltering confines of their native town, they will be exposed to the dangers of primary tuberculous infection and that at an age when the world beckons most invitingly and when prudence is least developed! In fact they would be in a hardly less dangerous situation than the tropical native when he first enters a civilized community. Prophylaxis has simply resulted in exchanging the danger of a chronic and usually relatively benign infection for the danger of an acutely fatal infection.

At the time when control of expectoration first bulked so large in the eyes of the sanitarian the community was divided in his thought into two classes as respects tuberculosis, the tuberculous and the healthy. Very slowly and reluctantly since that time the knowledge of the true facts has been acquired and still more slowly and reluctantly has it been disseminated — in fact it still seems incredible to many that tuberculization should be so well-nigh universal as it undoubtedly is. If it seems likewise a terrible fact that conclusion is erroneous. The error lies in the assumption that tuberculosis is necessarily an evil. We fix our eyes upon the advanced case of tuberculous disease, a pitiable sight indeed, and that for us spells tuberculosis, but we forget that such a case is the comparative exception, the illustration of a failure in immunization; we forget that the majority of the population never know that they are tuberculized! It is as if we confounded vaccination with smallpox and because the latter is a terrible disease we concluded that vaccination against it is also terrible! The simile is

of course, not perfect, for the laws of immunity against smallpox are not the same as the laws against tuberculosis. There is, therefore, all the more need that we shall set ourselves resolutely to work to establish beyond all controversy what the laws of tuberculous immunization really are. Becoming convinced that we must live with the tubercle bacillus, the next step is to learn how to get along with it on the best possible terms. There seems to be no reason why we should not aspire to the elimination of all manifest tuberculous disease — it simply means increasing the percentage, already so large, of the successfully vaccinated. The watchword should be: vaccination against tuberculosis for all — no manifest tuberculosis for anybody!

That all shall receive adequate vaccination without their knowledge or desire demands that the community shall be absolutely steeped in infection. Where all shall receive enough in the present haphazard method, many must receive too much. The Jewish race, longest devoted to the life of cities, shows the best vaccination. But even they pay dearly for their immunity by a considerable percentage of losses.

We have done our best during the last quarter century to diminish tuberculous infection, and something has been accomplished, no doubt, in lessening the size and frequency of infecting doses. Fortunately as yet we have not succeeded in diminishing by one iota the morbidity of the disease. Not that such diminution, and that to the point of extinction is not desirable, but we are not yet ready for it. For as soon as we diminish the morbidity the danger arises that the opportunities for tuberculization will likewise diminish, that after a deceptive lull cases of acutely fatal tuberculosis will begin to take the place of the former more benign types of the disease. We must provide against this

danger in our future program. This can only be done by substituting an artificial premeditated infection for the present infection by chance. G. B. Webb has already made a courageous beginning in this direction, but before the medical profession can be prepared to enter into the field on a large scale the study of one generation will be required in order to ascertain the necessary facts. We need to study the later history of those who were positive to the von Pirquet reaction as compared with that of the negative cases in each of the years of childhood in order to ascertain the year of life most favorable for infection, for we do not know from large series of cases what the relative probability as to the future development of manifest tuberculosis is of the negative and of the positive cases in the von Pirquet reaction in the different age groups. This involves the systematic use of the cutaneous tuberculin reaction on the children of all ages after infancy. The children who react positively would require no farther tests, those who give a negative reaction should be tested again each succeeding year (or more often if practicable) until a positive reaction is obtained. A careful record should be kept by name of all the children that have been tested and the history, particularly, of course, the tuberculosis history, of each child should be followed at least up to the thirtieth year. It being ascertained that a given child has recently become infected, proper steps can be taken to insure the best possible care for it, to the end that the infection may remain latent. There can be no doubt that the first half year after infection is a critical time for the child. Proper attention at this time would do more to lower the morbidity and mortality from tuberculosis than anything except preventing the infant from coming into contact with the consumptive. The work would be of great value if limited to

the acquisition of data to be utilized only for the prophylactic care of recently infected children. We should, however, aspire to more. What an enormous mass of valuable data is lost because acquired a little at a time by many individuals and never collated! Furthermore, many even of the facts that are of record lose much of their value because imperfectly recorded or because individual investigators introduce variations in their methods so that their results are not comparable with one another. It is also to be remembered that the observations to be of the greatest value must be continued for many years, probably beyond the lifetime of some who had been active at the inception of the work. For all these reasons it is necessary that the work shall be carried on by an organization. In view of the multitude of willing workers in the field of tuberculosis to whom could we better commit this task than to the local tuberculosis organizations, the Anti-tuberculosis Associations? Every local anti-tuberculosis association would then become a record office of the tuberculization of the community. The extreme value of such a series of facts quite aside from the question of artificial tuberculosis infection is plainly evident. The facts will be at hand after thirty years for that purpose if they are wanted, and in the meantime the guidance that they have furnished for prophylaxis and for treatment and the additions that they will make to our statistical information will have richly repaid the trouble of their collection. Small series of observations are worth very little. What is needed is an enormous number of entirely objective and easily ascertained facts which, with a little instruction, can be collected by any intelligent layman. The facts as to tuberculin sensitiveness are of course of prime importance, but data as to mode of infection would not be out of place — facts as to the entrance of

a consumptive into a family of young children, for example, should be recorded with especial care. It is highly important, however, that the records shall be confined to objective facts and that the observers shall not be too ready to identify, more or less by conjecture, the source of infection in the individual cases — it is unscientific and misleading to create classifications for hereditary infection, for infection by chance or ephemeral contact and the like. And it seems important to the writer that positive reactions shall be interpreted (in the absence of manifest tuberculous disease) in terms of vaccination and not in terms of tuberculosis. The child that has recently become positive to the skin test is usually not ill, but simply requires watching. To create a tuberculosis "scare" by labeling such cases "tuberculosis" would do much harm. Too great care can not be taken to guard against such an evil. In order that the statistics shall be homogeneous, tuberculin of the same strength (undiluted) should be used and the methods of scarification and of interpreting the results should be standardized as well as the methods of keeping the records, hence the control and oversight of the work should be in the hands of the National Tuberculosis Association.

An excellent beginning has been made at Framingham, Mass., where tuberculin is employed as one of the means of diagnosis. Much that is done there cannot be imitated elsewhere for lack of funds, but there seems to be no good reason why the benefits of the cheap and easy tuberculin skin test should not be extended to many communities where a general medical survey would be impracticable.

Some classes of our population change their residences so frequently that it will prove difficult to keep many of the children under oversight. For that, as well as for many other reasons, the numbers examined should be large. To

propose to examine ten thousand children may seem a too ambitious program, but could not twenty anti-tuberculosis associations easily examine and follow up 500 cases apiece? The writer is sanguine enough to hope for statistics from an even larger number of children.

Laboratory Problems

It has long been a source of surprise to the writer that so little interest has been taken in the question: What is the meaning of the negative percentage in tuberculin tests? Will all civilized adults react to tuberculin, if given in a sufficient dose, or is there a certain percentage which is really not infected at all with tuberculosis? Those who have followed the discussion of this subject will agree that the negative percentage must be a small one, at least in the large centres of population. Still it is of importance that the question shall be definitely settled. A tuberculin skin test in many remote farming communities in which tuberculosis seems to be rare would throw light upon the important question whether the absence or relative rarity of manifest tuberculosis disease means infrequent opportunities for infection or a high resistance.

As has already, however, been pointed out, the skin test must not be too implicitly relied upon as giving the true percentage of tuberculization of a group of individuals — it shows the greater part, not all of the tuberculous infection present. For the accurate determination of the tuberculosis situation in a given group or community we much need to supplement the findings of the tuberculin tests by some other procedure.

The complement-binding reaction at once suggests itself. But except that no objections can be raised as to its safety,

the complement-binding reaction in tuberculosis has the same shortcomings as the tuberculin tests, that is, it is a coarse test and does not reveal all of the tuberculosis present. Laboratory workers have exercised their ingenuity to produce tuberculosis-antigens which shall not be too sensitive but which, producing positive results only in active tuberculous disease, shall render possible the elimination from farther consideration of those in whom there has simply been "a previous contact with tuberculosis". But from the standpoint of those who would settle what the writer regards as the most important epidemiological question before the medical world — the exact amount of tuberculization of the civilized community — the antigens are less rather than more sensitive than they should be. According to Fishberg[1] the complement-binding reaction appears to be of about the same value in diagnosis as the von Pirquet skin reaction. Ninety-five per cent. of positive results have been reported in tuberculous cases and Craig[2] found 65 per cent. of clinically inactive cases of pulmonary tuberculosis to give positive reactions (these cases, however, being for the most part patients in a tuberculous sanatorium). Evidently if we expect the complement-binding reaction to detect all of the cases which have been in contact with tuberculosis, we should have at least 95 per cent. of positive results in healthy adults, for that percentage has been exceeded by the cutaneous test in some series and Opie[3] found one hundred per cent. of tuberculosis in autopsies of all persons eighteen years or over by his radiographic methods. Alstaedt[4] has stated that of the population of Hamburg which makes use of the public hospitals

[1] Pulmonary Tuberculosis, 2d Edition. 1919, p. 349.
[2] Am. Jour. Med. Sci. 1915, p. 781.
[3] Jour. Exp. Med. Vol. 25, 1917, p. 855.
[4] Beitr. z. Klinik d. Tub. Fourth Supplementary Vol., p. 246.

hardly a child reaches the threshold of its second year without giving a positive reaction to Deycke and Much's "partial antigens". This amazing statement should be confirmed by extended investigation before we can accept it as proof of so extensive and early tuberculization of young children. If true it shows that the complement-binding reaction may be made of extreme delicacy so that it may become an instrument for the detection of tuberculous sensitization superior to tuberculin, and may reveal a stage of earliest tuberculous infection to which biological tests have hitherto been blind. The subject would seem to urgently demand further investigation.

The individual laboratory worker who studies tuberculosis experimentally labors under the necessity of employing a dosage of tubercle bacilli which is excessive in comparison with the probable dosage of natural infection, because he feels that he must produce infection within a reasonable time and in such a way as to preclude the probability of confusion with intercurrent natural infections. Hence we know only too well what happens when infections have been produced by too large doses of tubercle bacilli, but very little as to the manner in which an animal should be infected in order to lead to the highest possible immunization. We know from the experiments of Römer that guinea pigs infected with minutest doses of attenuated tubercle bacilli require months in which to develop a reactivity to tuberculin, and Hamburger has shown that the length of the period of incubation varies in general with the size of the infecting dose. The dosage is therefore a matter of the highest importance if animal inoculation is to guide us in the study of the practicability of human inoculation. The minimal infecting dose of tubercle bacilli

has been ascertained and reported by several observers. Their results do not agree with one another and are of no value for one who would study small natural infections. For what they mean by minimal dosage is the dose that will produce an undoubted infection in so short a time as to avoid the criticism that such infection as may become apparent might not have been the result of the procedures adopted by the investigator.

Contact with the pneumococcus, the meningococcus and the diphtheria bacillus appears to effect a certain immunization, although there has never been an actual infection in the ordinary sense of the word. This is shown by the fact that carriers of these microorganisms, while by no means absolutely immune to attacks of the enemy which they harbor, are nevertheless distinctly less susceptible than those who have never had the opportunity to accommodate themselves to its presence.

May we not account for the superiority of the immunization of the civilized individual against tuberculosis in an analogous way? Evidently immunization in general is best effected when the earliest contact is occult. In other words, it is desirable to habituate the body-cells to the presence of a new poison in the most gradual manner. Hence for the best results actual inflammatory reaction should be deferred as long as possible after the reception of the virus.

Here is an almost untrodden field for investigation. What we need to know in tuberculosis is the result, after months and years, as to the acquisition of an immunization, of infections by the mouth and otherwise with minimal and small doses of tubercle bacilli in animals which have been most scrupulously shielded against reinfections. An enormous number of animals would be required in order to allow for losses by intercurrent disease and to guard against

the objection that positive results are due to chance reinfections. The time and expense would be so great that the investigation could only be undertaken by an institution with ample means.

Such study is an absolute prerequisite to any attempt at the artificial infection with tubercle bacilli of the human subject and the knowledge obtained by it of the natural history of the small tuberculous infection would compensate for the labor involved, even though some future investigator shall immortalize himself by the discovery of a method of immunization against tuberculosis by means of non-living antigens.

THE CARE OF THE TUBERCULOUS INDIAN

One of the most dangerous doctrines relating to prophylaxis is that good health prevents tuberculous infection. It is true, no doubt, that good health will prevent tuberculous infection from becoming tuberculous disease, but good health has nothing to do with the reception of the tubercle bacillus into the body. We have seen the evils which ensue when the consumptive comes into contact with an unprotected race. An American writer remarked fifteen years ago: "It seems that the Indian was free from tuberculosis before his contact with the whites, living as he did in the open air and without alcohol". J. D. Hunter,[1] after having been a captive among the Indians nearly a century ago, expressed the opinion repeatedly that intemperance was the principal cause of the prevalence of tuberculosis among them. Alcohol, however, can not be even an important accessory cause of tuberculous disease, as Hutchinson points out,

[1] Memoirs of Captivity among the Indians. London, 1822. Also: N. Y. Med. and Phys. Jour., 1822, p. 171. Cited by Hrdlicka, Bull. No. 36, Bureau of Am. Ethnology.

because when liquor is to be had at all there is never enough so that any can be spared for women and children. Hence the class that suffers most among them, the children, do not consume it. The writer would be the last to object to any measures calculated to improve the health of and to restrict drunkenness among the Indians, but the evil of such teachings is that they divert the attention from more important matters, that we shall be satisfied if regulations are adopted for the exclusion of alcohol, for example, and if it appears that alcohol is nevertheless not excluded, that we shall feel that at least we have done what we could to help, whereas nothing whatever has been done by us for the really important thing — the determination of the degree of tuberculization of the Indian community and the adoption of measures which shall protect those who most need protection. Hrdlicka[1] recommends that the tuberculin test (skin reaction) shall be applied to children who are to be sent to the large Indian schools and that all cases in which the reaction points to infection shall be denied admission. Now the large schools, especially the so-called non-reservation schools (one at Phoenix, Arizona, has a capacity of 1000 pupils) are objectionable if the children are not already immunized by previous infection because those who are not thus protected are very certain to become infected there. Severe tuberculosis in Indian schools has caused much trouble in the past and the regulation of the school life of the Indian child seems one of the measures that promise most in improving the conditions as to tuberculosis. Young children who are not likely to have already become infected should not be sent away to school at all. Older children (10 to 15 years of age) who are uninfected are in the gravest danger at such schools because it seems

[1] Loc. cit.

probable that within limits the older the individual is at time of infection the greater the danger in such infection. Therefore, in the writer's judgment, children should not be allowed to attend the larger schools unless they have a positive skin reaction to tuberculin. There is danger here that those who react positively may be on the point of breaking down with manifest tuberculosis of severe type, so that long railway journeys will lead to disaster. We would therefore make the further suggestion that no Indian child be sent to boarding school unless he is in apparently good health, shows at least no marked glandular involvement, gives no physical signs of tuberculosis of the lungs and has been positive for the von Pirquet reaction for at least one year. In other words, a tuberculous vaccination should be required as well as a vaccination against smallpox.

Some of the Indian tribes have been studied to ascertain what percentage of families were free of suspicion of tuberculosis. Hrdlicka reports that among the Menominee Indians 40 per cent., among the Sioux 34 per cent., and among the Mohave Indians 58.2 per cent. of families appeared not to have tuberculous members. But inspection, anamnesis and even physical examination are not enough to determine such facts. The idea is a good one so far as it goes but the cutaneous test should be resorted to. If as the result of such a test it should appear that the parents or the older children of a family have a positive skin reaction, the child in question might be permitted to go to the local school, the idea being that if not already infected at home he soon will be. But if the majority of the family groups are really not infected at all, it might be well to exclude all that react positively and confine the school privileges to the

uninfected, or possibly provide separate schools for the two groups.

However desirable it may be that children should be infected with tuberculosis at a comparatively early age, in the present state of phthisiology one would not perhaps be justified in deliberately exposing an unprotected individual to the dangers of chance infection, yet at the same time it should be emphasized that the dangers of primary infection in the active years of later childhood are so great that the negatively reacting individual should be regarded as one who especially requires protection.

Tuberculosis in German Southwest Africa

The natives of German Southwest Africa having revolted against the Germans, lost heavily in the ensuing warfare. Von Trotha, according to the British Blue Book,[1] issued his order of extermination of the Hereros in August, 1904. Many defenseless women and children, as well as warriors, were killed as the result of this order and the tribe, though not exterminated, was reduced from some 80,000 to 90,000 souls to about 15,000 at the end of 1905, when von Trotha relinquished his task. Altogether about two-thirds of the native population had perished when peace was made. Besides losses in combat, according to Külz, there were losses incident to the assembling of workers for tribute. The prisoners of war who were sent away perished for the most part. After pacification a station was built and the people were required to work, at first in payment of tribute, at a later time in payment of taxes. They were in part compelled to change their places of residence in order to be under closer supervision. New lands had to be cleared of

[1] Report on the Natives of Southwest Africa and their Treatment by Germany. British Blue Book, August, 1918.

tropical growth with primitive instruments, for the people were not only obliged to raise their own food but also to provide for the multitude of strangers who now penetrated the country. The land that formerly knew little of traffic, says Külz,[1] was now traversed, not by hundreds, but by thousands of bearers and traders, who brought wares in exchange for rubber. All of these thousands had to be fed from the fields though the natives starved; and indeed famine made its appearance among them in some places. This led the way for smallpox and dysentery, which prevailed most in the parts most traveled, so that the sorely tried and discouraged remnant saw their numbers still farther reduced by acute infectious diseases, as well as by those other gifts of civilization, syphilis and alcohol. As for tuberculosis, Külz says that it is undoubtedly present though not yet widespread. Under the circumstances it will surely prevail, as it has elsewhere, and in time its ravages may surpass those of the more acute infections. Its dangers have been ignored in the past until it was too late. Civilized nations, not excepting our own, have a heavy burden of responsibility for ignorant, if not cruel, neglect of helpless peoples who have come under their dominion. It has been ignorance rather than cruelty in the past, so far as tuberculosis is concerned, but the excuse of ignorance ought no longer to be accepted.

The desideratum, of course, is the prevention of massive infections, a most difficult problem under the conditions. At least a benevolent government can diminish the burdens formerly placed upon the afflicted race until such time as the people have been able to recuperate. In many cases, no doubt, the question whether infection with tuberculosis shall result in immunization or death depends upon the way

[1] Archiv. für Rassen-u. Gesellschafts-Biologie. Vol. 7, 1910, p. 533.

in which the individuals are treated. Exploitation of the natives in Africa and elsewhere is responsible for much of the frightful mortality which has reduced to a handful so many once powerful tribes.[1] The policy of the Germans in Southwest Africa, in peace as well as in war, as some of their own writers admit, was calculated to cause the gradual disappearance of that population upon which the future of the colony depends. There is every inducement from an economic as well as from a benevolent point of view to take up the prophylaxis of tuberculosis as seriously as that of other preventable diseases.

Problems in Comparative Epidemiology

When Naegeli was making his classical investigations as to the percentages of tuberculosis to be found at autopsy, he was led to the conclusion that localized fibrous tracts leading from the hilus to the surface of the apex practically always indicated an old tuberculosis even though microscopic study did not discover any histological changes that were absolutely characteristic.[2] And, he says, he reached that conclusion because he found an unbroken series of transition pictures which progressed from typical tuberculosis to those findings which in themselves prove nothing. With this interpretation Naegeli found 97 to 98 per cent. of positive cases. Burckhardt,[3] who made a similar inves-

[1] "It is claimed that the (labor) traffic will depopulate the sources of supply within the next twenty or thirty years. Queensland is a very healthy place for white people — death-rate 12 in 1,000 of the population — but the Kanaka's death-rate is away above that. The vital statistics for 1893 place it at 52; for 1894 (Mackay district), 68. The first six months of the Kanaka's exile are peculiarly perilous for him because of the rigors of the new climate. The death-rate among the new men has reached as high as 180 in the 1,000. In the Kanaka's native home his death-rate is 12 in time of peace and 15 in time of war. Thus exile to Queensland is twelve times as deadly for him as war". Mark Twain, Following the Equator, 1897, p. 88.

[2] Virchow's Archiv. Vol. 160, p. 426.

[3] Zeitschr. f. Hyg. u. Infekt. Krankhtn. Vol. 53, 1906, p. 139.

tigation and counted only those cases tuberculous which showed either calcifications or caseations, obtained 91 per cent. of positive cases in his autopsies, yet he admits that Naegeli's percentages very probably represented more nearly the true facts. Whether we are willing to make the same admission or not, it is believed to be true that such localized fibroses in the large majority of cases indicate tuberculosis. It is one of the most interesting facts in the radiography of the lung that by it similar fibroses are found to be almost universal. Just as Naegeli found an unbroken series of fibroses proceeding from the non-pathognomonic to the pathognomonic, so the X-ray shows in apparently healthy persons an unbroken series of localized opacities extending upwards from the hilus as thickened lines, some of which reach the surface of the apex, while others appear to terminate in the deep lung. Of the latter group, some show dots at the bifurcation of the bronchi, which undoubtedly indicate tubercle, others similar in other respects do not. Of those that frankly reach the pleura, some terminate in what are evidently tuberculous foci, while in others, perhaps, only a superficial branching of the thickened lines is to be made out in the apex. Recent experience has, moreover, convinced the writer that the opacities in question more frequently reach the apex than may appear, the thickened lines in apparently healthy persons being often so delicate as to be revealed only by an unusually happy exposure and development. We are justified in the view that the X-ray findings in general confirm the presence of that practically universal tuberculization of civilized adults which has been so abundantly proved to exist by tuberculin tests and autopsy findings. Now, the importance of that surprising fact in the present connection is this: it shows that successful vaccination against tubercu-

losis in the large majority of our race is obtained, not as an invisible sensitization and immunization of the body-cells solely, nor solely as a lymphoid hyperplasia in lymphatic glands, but at the cost and at the risk of a deep lymphangitis, which heads toward the place of danger, the superficial lung. The difference between the lymphangitis with and the lymphangitis without extension to the apex, and also the difference between an apical process that heals, often without the subject having been aware of its existence, and one that extends as an active superficial lesion of the parenchyma seems fundamentally very slight from the anatomical point of view.

What is it that enables the tubercle bacillus to progress in the less well localized lesions? First of all, of course, the resistance, the degree of immunization of the subject, but the amount of blood present is also an important factor. Other things being equal, that case will be in the greatest danger of a progression of the disease in which the congestion of the lungs is most marked. True, the congestion of the focus is related to the intensity of the inflammation, so that we come back again to the resistance of the individual, nevertheless improvement is effected by diminution of the congestion of the lung through measures which do not directly depend upon the degree of immunization. We know that artificial pneumothorax will often arrest an otherwise progressive tuberculosis. Here collapse of the lung effects rest of the diseased parts and also ultimately a relative dryness of the pulmonary tissues with a diminution of the amount of the circulating lymph, the benefit of rest of the lung being usually explained as due to the fact that poisoned lymph is no longer so freely spread through the healthy parts by the movements of respiration.

We are therefore justified in asking the question: is it possible that the scale may sometimes be turned against the patient by a congestion of the lung, from causes more or less independent of the intensity of the focal inflammation? A question of this nature could not be answered in the individual case in such a way as to compel acceptance, but light could, it would seem, be thrown upon it by epidemiological study in which nations or large groups of individuals of different nations are compared with one another.

Is it true that the Chinese, though thoroughly tuberculized and though defying most of the laws of hygiene as we understand them, have as low or lower rates of tuberculosis mortality than we do; that they have less pulmonary congestion, less pneumonia than we do? If this is true, is the explanation that which they would give, namely, that it depends upon diet? Or is low mortality from tuberculosis due to a more perfect tuberculization of the Chinese? The Chinese, while not vegetarians from choice, are largely so from necessity. We have been told by Kitisato that the prevalence of tuberculosis is about the same in Japan as in European countries. How do selected communities in Japan and China compare with one another as to types, incidence and mortality of tuberculosis, as to the degree of tuberculization (positive percentages in the tuberculin skin test) and as to the amount of animal food consumed? How do the Japanese compare with the Chinese as to the prevalence and mortality of pneumonia? It is of enormous importance to epidemiology to determine whether in case there is really a lesser prevalence of tubrculosis and pneumonia in China the explanation is that nearly every one is a carrier, or whether, on the other hand, the tubercle bacillus and the pneumococcus are relatively rare.

The hygiene of the population of Bombay, as we have seen, is described as bad. But the death rates, already

quoted, are not high, certainly not as high as would be expected in one of our cities, if seventy-five per cent. of the inhabitants lived in a single dark, ill-ventilated room in almost tropical heat. What is the tuberculization of the population, what the prevalence of pneumonia and pulmonary congestions, if less than with us, what the nature of their diet?

Such suggestions are simply examples of some of the possibilities in what might be called Comparative Epidemiology. Similar inquiries might be profitable and might be more easily made in many other fields. Concerted effort could easily accumulate such a body of facts as to settle beyond all peradventure some of the basal questions in tuberculosis on which there is as yet no agreement. It is thought particularly desirable to learn the real facts as to tuberculosis in China and India, countries of ancient civilization in which tuberculosis has prevailed from time immemorial, but, as already remarked, much that is important could also (and more easily for Americans) be learned from study of the tuberculosis of islands such as Samoa and Porto Rico, the date of the introduction of the disease being comparatively recent in the former and probably of considerable antiquity in the latter.

No doubt superstitions and racial prejudices will often interfere with the collection of the desired facts, but, it is thought, the von Pirquet test could well be given in connection with vaccination for smallpox (this has been done in some places), and facts as to the types, morbidity and mortality of tuberculosis could be obtained when a census is taken.[1]

[1] The Bureau of Health of Manila publishes in its annual report the mortality statistics for all important diseases by ages and nationalities.

Too long we have been content to base our views as to the pathology and therapeusis of tuberculosis upon observations in a restricted field. The study of the tuberculosis of uncivilized peoples is of great value in demonstrating what the course of truly primary tuberculosis of the adult is and thereby furnishing the only satisfactory explanation for the apparent immunity from tuberculosis of the majority of the members of civilized communities.

But the writer is not at all convinced that equally important data might not be obtained from a tuberculosis survey of the teeming cities of the oldest civilizations.

And to any one who should be prompted to enter upon such investigations, we would commend the saying of Liebman:[1] "One can not search after truth and yet at the same time attempt to decide in advance whither the way should lead".

[1] Quoted by Deycke, Med. Krit. Blätter. Vol. 1, Heft 1, p. 72.

CHAPTER XIII

SUMMARY AND CONCLUSIONS

In the days when consumption was not regarded as an infectious disease it was believed to be due to climatic conditions which, however, affected only the individuals who had the appropriate diathesis. Attempts to explain the incidence of the disease under widely varying conditions of climate led to all manner of contradictions, which became more marked when the study of tuberculosis was carried to remote parts of the globe and it was discovered that the disease raged more severely in the most salubrious islands of the Pacific than in the bleakest regions of the old world.

In studying the dissemination of tuberculosis throughout the world, it appears that, as respects the types of tuberculosis, the various countries are divided into two classes. In the one, tuberculosis is widespread, as with us; in the other it is relatively rare, but the cases that do occur are rapidly fatal, although under conditions favorable for it the disease may prevail as an epidemic and exterminate entire families and even tribes. This observation is formulated in the law of Römer, which is: Where tuberculosis is a rare disease the cases that occur will be acute and fatal. Where the disease is common the type will be chronic and relatively benign. In other words, contact with tuberculosis affords a certain protection against it.

In the civilized community the apparent immunity of the majority of the population was accounted for by the supposition that a certain predisposition was necessary for the establishment of the disease, that healthy persons had a

degree of natural immunity against it and that adults, by reason of their maturity, had a higher resistance than young children. But when the facts of the incidence of tuberculosis in certain remote parts of the world became known, it appeared that there the disease operated in a different manner, that it spared no age of life and no condition of health, comporting itself in short like other infectious diseases. The natural explanation for this difference was that it was a question of race, the race under consideration having a greater proclivity to tuberculosis than the older races, in which the disease is apparently less easily acquired, and this is still the usual explanation of the phenomenon. It is found, however, on closer observation, that some individuals and communities show a much higher resistance to tuberculosis than do other individuals and communities of the same race, also that in certain regions the type of tuberculosis has greatly changed after decades of exposure to the disease from the acutely fatal to the chronic and relatively benign. When in a mixed population certain nationalities seem to be more attacked by the disease, than others, given an equally long exposure to it, the explanation is usually to be found in social and economic rather than in racial conditions.[1]

Now, if, under certain conditions, tuberculosis acts as a communicable disease, its morbidity being in direct relation to the exposure to it, and if this is not due to differences of race, it becomes difficult to account for the apparent immu-

[1] No support is given by experiment to the belief that either an increased predisposition or an increased resistance to tuberculosis can be inherited, the offspring of tuberculous parents being neither more or less prone to tuberculosis than other animals of the same species under similar conditions. It may be admitted that it is quite probable that some strains of a certain race are naturally more susceptible to tuberculosis than others and that, the less resistant individual dying out, there may be in a sense a survival of the fittest among the peoples longest in contact with the tubercle bacillus. The supervention of an immunization, however, takes place too rapidly to permit this factor to be given much weight.

nity of the majority of the members of the civilized community on grounds of health. In fact, it is impossible to do so now that it is known that practically all civilized adults, even the most healthy, have undergone a tuberculous infection. The discovery of this fact is of hardly less importance in phthisiology than the discovery of the tubercle bacillus. Already indicated by observations at autopsy, it was not widely accepted until the brilliant work of von Pirquet and others with the tuberculin reactions proved beyond cavil that, in European cities at least, the adult population was thoroughly tuberculized. The facts obtained by radiography on the healthy subject, which show that there is usually evidence of a localized deep-seated disease of the lung that differs only in degree from that which goes on to produce clinically manifest tuberculosis, corroborate fully the results of the tuberculin tests and the findings of the autopsy table. There is a large body of proof from three sources in support of the proposition: The civilized adult, almost always, if not invariably, has a tuberculous infection.

Unfortunately, the tendency has been to minimize the results of these investigations or to attempt to explain them away, rather than to face the issue squarely and to establish the real facts. The importance of knowing, for example, whether in remote places in our country where, perhaps, there have been no known cases of tuberculosis for many years the inhabitants have received the benefit of a tuberculous infection or not, is only fully realized when we study races and peoples who have not become well tuberculized. But such study in itself furnishes an answer to the above question, for tuberculosis among the unprotected, sweeping away, as it may, all the members of a family, even sometimes of a tribe, is found to have terrors entirely foreign

to our usual experience.[1] We then comprehend that our race must have become tuberculized and consequently immunized, otherwise it, too, would have perished.

If all are tuberculized and if, in contrast to what occurs where it is a new disease, the civilized community derives a large measure of protection against the more deadly forms of tuberculosis by reason of that tuberculization, the large majority of the population not only escaping manifest disease, but escaping it as well when much, as when apparently not at all exposed, it logically follows that the tuberculous infection has conferred an immunity against infection from without, also, of course, that when tuberculosis does become manifest the cause is an extension of the infection already present in the body of the individual (if the disease is of the usual chronic type which would exclude immediately antecedent infection). The inference is supported by analogy with the facts of other infectious diseases — in malaria there is no reinfection with organisms of the same type, in syphilis reinfection does not occur until the disease has become cured. There is no good reason why disease caused by the virulent and highly resistant tubercle bacillus should form an exception to the law that reinfections do not take place so long as the infectious agent is present.

There has been a marked diminution of late years in the mortality from tuberculosis, practically none in its morbidity. But the mortality from tuberculosis rises and falls, in a general way, with the general mortality and is influenced like the latter by causes that operate to improve or to deteriorate the conditions of health of the community.

[1] Grenfell finds that in the remotest parts of Labrador the tuberculosis of the whites is sometimes of an acute and extraordinarily fatal type. (Personal communication to Estes Nichols.)

Statistical study shows that such changes occur almost exclusively in the mortality of chronic phthisis and not at all in the mortality of tuberculosis when it occurs as an acute disease — primary tuberculosis acts like an infectious disease, chronic phthisis does not. The infection of tuberculosis, in other words, whether it declares itself at once as a manifest disease, or only after the lapse of years, or not at all during a long life, takes place when there is an opportunity for the tubercle bacillus to enter the body, quite independently of the health of the individual, the sanitary conditions of the community in which he lives, etc. Whether infection, once received, shall become manifest disease or not depends first of all upon the size of the initial infection, but in all except the largest infections also upon the health of the individual which is largely influenced, in turn, by the sanitary conditions which surround him. To prevent infection we must stop the dissemination of the tubercle bacillus; to prevent the already infected individual from developing tuberculous disease we must regulate the conditions of his health. We have effected something in the latter direction, nothing at all apparently in the former.

The belief that consumption is not infectious was based upon an enormous experience, but very naturally seemed erroneous when the infectious agent became known. The study of many years was required to show that the belief contained an element of truth, that consumption is not infectious for those who have already a tuberculous infection, even though it be occult.

When the infectiousness of tubercle was not known no connection, naturally, was seen between the brain fever of the infant, the scrofula of the child and the consumption of the adult. The error of our fathers lay in failing to appreciate the fact that consumption, though indeed not infec-

tious for the civilized adult, was sowing bountifully on every side the seeds of death for the child unprotected by a previous infection with tuberculosis. The error of modern times is to deny the protective influence of tuberculous infection against renewed infection from without. Thus is solved the riddle of the centuries. Our fathers saw one side of the shield, we have concentrated our attention too much upon the other!

The immunity in tuberculosis differs from that derived from vaccination because it depends upon a continuing infection. It is, therefore, in a sense, stronger than vaccination because constantly renewed, but it has a serious element of weakness in that it demands a constant active resistance which may be overcome, so that the subject, though immunized against tuberculosis, may nevertheless die of it! Now, immunity against a disease is, properly speaking, an immunity against the infectious micro-organism. It does not necessarily remove the results of the infectious inflammation. Thus, in the case of a boil the afflicted individual has a high immunity against the pyogenic organism that caused the boil, for he does not die of septicemia, though the bacteria may at times be found in the blood, yet he is dependent upon the knife of the surgeon to evacuate the contents of the abscess. Similarly with regard to the gumma of syphilis, though the subject be immune against reinfection and though he does not permit his disease to extend more widely, his immunity nevertheless can not do away with the gumma without help. So in tuberculosis, caseous foci of any considerable size are not destroyed by the immune powers of the human organism; they must be walled in by connective tissue, or must escape by ulceration, constituting a constant menace so long as they are present in the body.

We recognize two degrees of immunity in tuberculosis: First, immunity against the tubercle bacillus. The tuberculous subject who is not overwhelmed by a too massive original infection has an immunity against the tubercle bacilli which circulate in his blood from time to time and also against those which may enter the body from without. Second, immunity against tubercle bacilli and the accumulations of their poisonous products, such immunity not being understood as power to eliminate such collections, but simply as the ability to restrain existing foci from extending. It might, perhaps, be better expressed as the ability of the living tissues to maintain their vitality when bathed in juices poisoned by the tubercle bacillus.

Given, therefore, the presence of a good-sized caseation (which may be the consequence of a large infection, or of some later lapse in the immunity), the prognosis becomes doubtful in direct proportion, other things being equal, to the size of the focus. The subject may die of an extension of his disease, but in pulmonary tuberculosis will preserve until near the close of life the first degree of immunity, that is, he will develop no distant foci due to his own bacilli and will be immune to the incursions of tubercle bacilli from without.

From a wide survey of the incidence and severity of tuberculosis in many countries it would seem, if we may trust the facts obtainable, that the degree of immunization is the highest in the oldest and most stable communities and that the immunization of the savage or semi-civilized community is less satisfactory than that commonly obtained in our civilization. This we would ascribe to the constant interchange in our civilization of articles that pass through many unknown hands which practically insures the ubiquitousness of the dried tubercle bacillus, which is an

advantage, for it insures that the inevitable and indeed desirable tuberculization shall be accomplished in most cases by means of a somewhat attenuated bacillus and that the infecting dose will be usually small.

Tuberculous infection does not appreciably affect the health of the large majority of the population who remain throughout life immune to tuberculous disease. A certain percentage, however, represent failures of the immunizing process, but in many if not the greater part of these the failure in the immunity is partial and comparatively slight, so slight that we encourage every one to hope for recovery and that, so nicely balanced are the forces of offense and of defense, we expect the scale to be turned in the right direction by the means of such comparatively trivial remedies as a little more rest, fresh air and nourishing food! Not thus does one cure primary tuberculosis; the sanatorium treatment would be folly, if it were not that we can count upon the assistance of an immunization which can generally be easily induced to reassert itself.

Experience shows that many of the tuberculized have an iron immunity which no fatigue, hardship or intercurrent disease can shake, but there is a vast number of persons, in the aggregate, whose fate as to the outbreak of manifest tuberculosis will depend upon the state of their health. It should be one of the achievements of the future to determine why there is this difference in the amplitude of the margin of safety of the two groups. We may conjecture that it consists usually in a larger initial infection in the less resistant class; that this is not the sole cause appears to be shown by the rare cases in which miliary tuberculosis attacks an individual who has but very slight and old tuberculous lesions.

Modern civilization brings with it inevitably a tuberculization. There appears to be no escape from this without more radical changes in our mode of life than can be reasonably anticipated, so long as the cow continues to play a prominent part in supplying the daily food. There is, however, no reason for alarm in the fact that the modern world is a tuberculous world. The present situation doubtless leaves much to be desired, but it is to be remembered that it has greatly improved within the last fifty years without our conscious interposition — what can we not make of it when we do our best! We have simply to follow the indications that nature grants us and resolve that the already large percentage of the immune shall be increased to one hundred per cent! Better care of the infant and the inauguration of an intelligent instruction of the mothers is the best way in which so happy a state can be approximated. The study of the tuberculosis of the Orient leads to the suspicion that good hygiene, however important and highly to be desired it may be, is of distinctly minor importance in comparison with an optimal tuberculization.

The infants who die with miliary tuberculosis are sacrificed uselessly — they contribute nothing to the maintenance of the tuberculization of the community. On the other hand, the consumptive, much to be dreaded as he is at close quarters for the uninfected, is indispensable in the present era because he unwittingly provides for that immunization which prevents our race from perishing as so many other races have perished when thrust unprepared into the midst of infection. Whether a correction is needed here because the healthy bacillus-carrier could perform this function unaided is a doubtful question, the answer to which can only be obtained by much investigation.

However that may be, should we not look forward to the time when nature's methods of tuberculization, so terribly wasteful of human life, shall be replaced by a thoroughly scientific method of artificial inoculation in which no life will need to be sacrificed?

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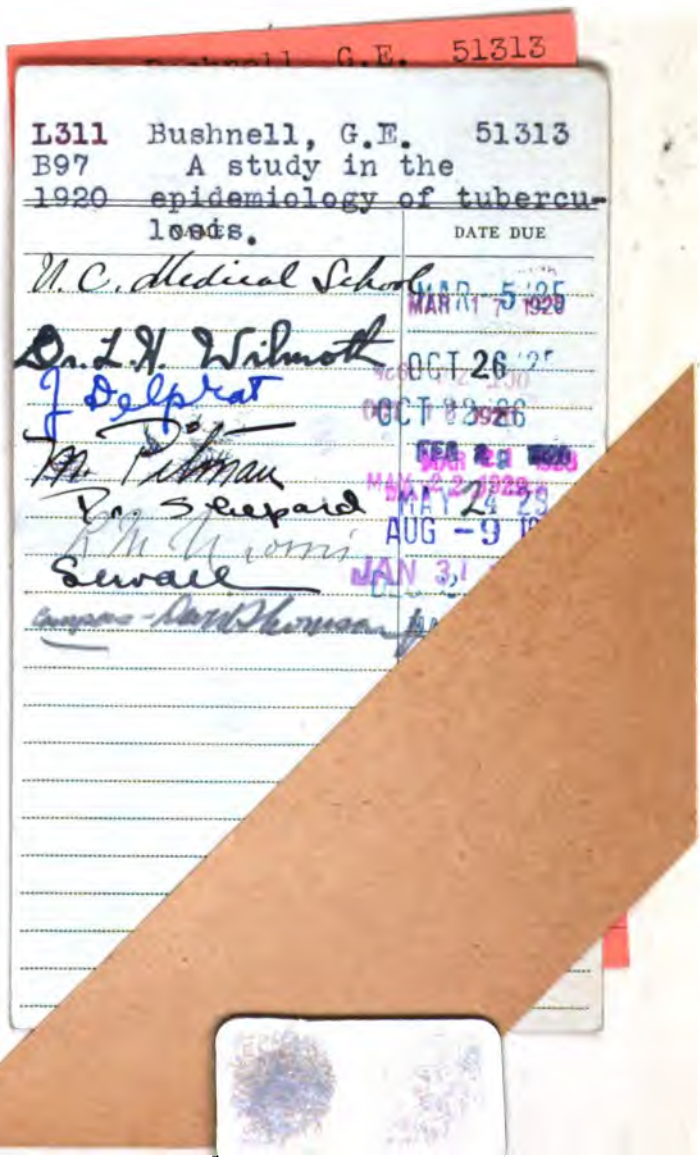
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